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GCA Corp, Bedford, Mass GCA Technology Div

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NATIONAL ASSESSMENT OF THE URBAN PARTICULATE PROBLEM

Volume XV - St. Louis Area

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This document is one volume of a sixteen-volume report presenting an overall assessment of the particulate problem, which was conducted by GCA/Technology Division for EPA.

This particular document is one of fourteen single-area volumes that provide working summaries of data gathered in the fourteen urban areas studied. These city reports primarily provide documentation and background information for Volume I of the study - National Assessment of the Particulate Problem - Final Report. Volume I should be considered the primary output of the report.

Descriptors	Identifiers/Open-Ended Terms	COSATI Field/Group
Particulate Matter Total Suspended Particulate Emission Sources Control Methods Air Quality Measurements	Optical Microscopy Secondary Particulates Fuel Combustion Process Emissions Fugitive Emissions Fugitive Dust Monitor Siting Meteorology	

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NATIONAL ASSESSMENT OF THE URBAN PARTICULATE PROBLEM

Volume XV

St. Louis, Missouri Metropolitan Area

FINAL REPORT

by

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Prepared for

ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Waste Management
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

June 1976

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FOREWORD

This document is part of a 16-volume report assessing the urban particulate problem, which was conducted by GCA/Technology Division for EPA.

This particular document is one of the 14 single city volumes that provide working summaries of data gathered in the 14 urban areas during 1974 to support an assessment of the general nature and extent of the TSP problem nationwide. No attempt was made to perform detailed or extensive analyses in each urban area. Rather, the city reports are intended as a collection of pertinent data which collectively form a profile of each urban area. This, in turn contributes to a comparative analysis of data among the 14 areas in an attempt to identify general patterns and factors relating to attainment of the TSP problem nationwide. Such an analysis has been made in Volume I of the study-National Assessment of the Urban Particulate Problem-National Assessment. The reader is referred to this volume as the summary document where the data is collectively analyzed.

The 16 volumes comprising the overall study are as follows:

Volume	I - National Assessment of the Urban Particulate problem
Volume	II - Particle Characterization
Volume	III - Denver
Volume	IV - Birmingham
Volume	V - Baltimore
Volume	VI - Philadelphia
Volume	VII - Washington
Volume	VIII - Chattanooga
Volume	IX - Oklahoma City
Volume	X - Seattle
Volume	XI - Cincinnati
Volume	XII - Cleveland
Volume	XIII - San Francisco
Volume	XIV - Miami
Volume	XV - St. Louis
Volume	XVI - Providence

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EXECUTIVE SUMMARY

AIR QUALITY LEVELS AND TRENDS

The 1975 geometric mean TSP concentrations in the St. Louis Metropolitan Area ranged from 40 $\mu g/m^3$ at a remote site to 50 to 70 $\mu g/m^3$ at the residential sites, 60 to 80 $\mu g/m^3$ at the commercial sites, and generally over 80 $\mu g/m^3$ at the industrial sites. Sixteen of the 33 sampling sites exceeded the annual primary standard and 10 other sites exceeded the annual secondary standard. The 24-hour primary standard was exceeded on 16 sampling days (1.1 percent) and the 24 hour secondary standard on 131 sampling days (8.7 percent). Records show that air quality has been improving since 1969 - sites in St. Louis County showed an average decrease of 21 $\mu g/m^3$, sites in St. Louis City, an average decrease of 73 $\mu g/m^3$, and sites in Madison and St. Clair Counties in Illinois an average decrease of 50 $\mu g/m^3$.

REGIONAL SETTING

The St. Louis Metropolitan Area is located immediately south of the confluence of the Mississippi and Missouri Rivers. The Metropolitan Area spans the Mississippi River and includes counties in two states - St. Louis and St. Louis City in Missouri and Madison and St. Clair in Illinois. Due to its location, St. Louis has become an important center of rail and river transportation and manufacturing.

The St. Louis area is located on a broad, flat plain which is cut by the wide and shallow valleys of the Mississippi and Missouri Rivers. There

is a high degree and a wide variety of manufacturing activity, most of which is located along the Mississippi River.

METEOROLOGY

St. Louis has a continental climate, averaging 4750 heating degree days per year and 36.6 inches rainfall per year. The area experiences frequent migrations of low pressure systems but infrequent stagnations of large high pressure systems.

Due to the continental-type climate, poor dispersion conditions frequently occur at night and in the fall and winter seasons. The river valley, though shallow, is sufficient to induce frequent inversions which trap the pollutants emitted by the industries located along the river. Early morning temperature inversions occur on about 65 percent of all days.

Transport levels of TSP in St. Louis have not been quantified. However, because of the rural character of the surrounding region, nonurban levels are lower than in the more generally industrialized areas in the northeastern part of the nation.

URBAN ACTIVITY

An extensive urban renewal program has been conducted in St. Louis for the past 20 years. In general, data is not available to quantify the effects of construction activity on TSP concentrations, except for the Market Street monitoring site (site 20) where concentrations increased 70 $\mu g/m^3$ during 1969 and 1970 while land clearing and construction of the nearby Post Office building was occurring. There is a strong relationship between annual TSP concentrations and the predominant land use surrounding the monitoring sites. Traffic counts did not show a correlation with TSP concentrations.

REGULATIONS AND ENFORCEMENT

The process weight and fuel combustion regulations for St. Louis city and county are much the same. The process weight regulations are average in stringency when compared to the regulations of most states in the nation. Two fuel combustion regulations evaluated in the study. No attempt was made to evaluate the effect of tightening the fuel combustion regulations to average stringency; this would require a more detailed analysis since many sources may have overcontrolled and would meet more stringent regulations. The Illinois regulations are average or greater than average in stringency. Three agencies are responsible for surveillance and enforcement in the metropolitan area - the Division of Air Pollution Control for the City of St. Louis, the Air Pollution Control Division for St. Louis County and the Illinois EPA and its Region IV Field Operations Office for Madison and St. Clair Counties.

The St. Louis City and St. Louis County regulations were adopted in 1967 and efforts were made to obtain compliance of sources as soon as possible. Most companies were cooperative. Compliance is determined by calculating emissions and according to this, all companies and all incinerators except the St. Louis housing authority are in compliance with the regulations. There is a "hot spot" at the southern tip of the city where two industries are causing high TSP concentrations. Further emission reductions can be made at this hot spot even though these sources have already made their maximum reductions under the regulations. This is because emission limitations of general applicability; i.e., process weight, are not adequate to solve the problem. The State of Missouri has a "hot spot" regulation authority which would be appropriate here. The Illinois regulations were adopted in 1972 and efforts to obtain compliance have been made since then. Most companies in Illinois Region IV are now in compliance or on a compliance schedule. Major emission problems still exist in Madison County.

EMISSIONS

The St. Louis Metropolitan Area is highly industrialized. The major sources of particulate emissions are industrial processes and industrial and utility fuel combustion. The sampling sites in the industrial areas of St. Louis have consistently recorded the highest TSP concentrations and continue to exceed the national annual primary standard. The results of an EPA modeling study point to industrial processes and area sources as being important contributors to TSP concentrations above background levels at certain sites. The study also indicates that uninventoried sources are important at some sites. Considerable reductions in particulate emissions have occurred due to switching from coal to natural gas in homes, industries and utilities since the 1950's; also to emission controls on industries since the promulgation of air pollution control regulations in St. Louis City and St. Louis County in 1967 and in Illinois in 1972. Further emission reductions are expected as all sources come into compliance.

PARTICLE CHARACTERIZATION

Analysis of 26 filters from six sites in the St. Louis area by optical microscopy showed that on the average three-quarters of the particulate material was composed of minerals and one-quarter was composed of combustion products. A number of fugitive dust sources were implicated as contributing to the high mineral content, but the relative contributions of these sources was not determined.

NETWORK DESIGN

The design of the monitoring network in St. Louis City is generally adequate for recording air quality in the various kinds of land development in the city; in St. Louis County, coverage is adequate except that the large rural areas are represented by only one monitor; the Illinois

counties' industrial and commercial areas are represented but there are no residential and rural sampling sites. Monitor siting varies considerably with respect to height, exposure, and local sources. Some problems have been alleviated recently but some probably continue to affect sampling.

IMPLEMENTATION PLANNING

The Missouri SIP used 1971 air quality data, an emissions inventory updated to 1970, and the regulations adopted in 1967 in the modeling. The regulations included a "hot spot" regulation which requires additional emission controls on industries already meeting the emissions standards if air quality in the vicinity continues to exceed the standards. The results of the modeling showed that the secondary TSP air quality standard would be met when full compliance with the current regulations, including the hot spot regulation, was achieved.

The Illinois SIP used emissions, air quality, and meteorological data for 1968. It was determined that the annual secondary TSP standard would be attained and maintained with the enforcement of the Illinois regulations which were adopted in 1972, provided that the Missouri regulations were fully enforced, including the "hot spot" regulation, and the secondary standard was attained on the other side of the river.

CONCLUSIONS

The high TSP concentrations experienced in the St. Louis Metropolitan Area are the result of emissions from the large numbers of industries, especially the many heavy industries, and probably also the fugitive dust and emissions of the industrial areas. TSP concentrations have been gradually decreasing over time due to decreasing emissions from coal combustion and from industrial processes and fuel combustion. Further reductions in emissions and corresponding improvement in air quality can be anticipated. But, it is likely that a few areas will continue to exceed the standards due to the topography, land use patterns and meteorology of the area, and fugitive dust and fugitive emissions.

SECTION 1

INTRODUCTION

CITY CHARACTERIZATION

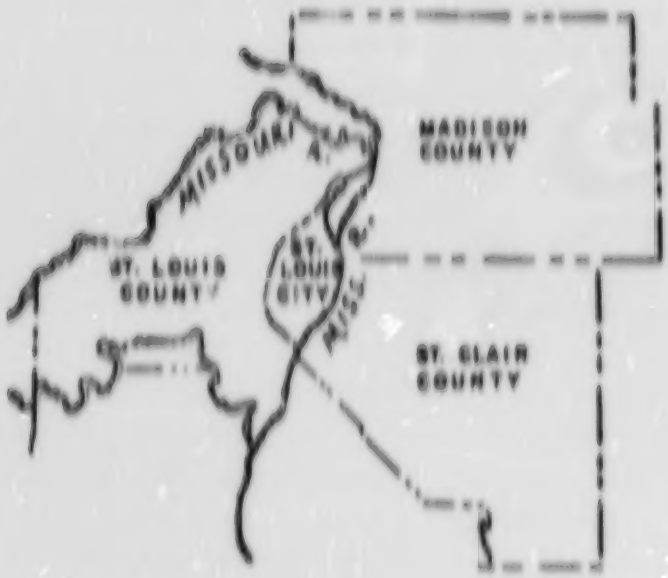
The St. Louis Metropolitan Area is located immediately south of the confluence of the Mississippi and Missouri Rivers. The Metropolitan Area spans the Mississippi River and includes counties in two states, St. Louis and St. Louis City in the State of Missouri and Madison and St. Clair in the State of Illinois - see Figure 1. These 4 counties are the central part of the larger, 11-county Metropolitan St. Louis Interstate Air Quality Control Region. Because of its central location in the nation, the St. Louis Metropolitan Area has become an important center of rail and river transportation and of manufacturing and industry.

Topography and Climatology

The St. Louis area is located on a broad, relatively flat plain which is part of the midwestern plain states. The plain is cut by the Mississippi and Missouri Rivers which form wide and shallow valleys. The area is remote from any significant topographic features which would influence large-scale air flow through it so air flow is generally unhindered.

The City of St. Louis is located on a bluff overlooking the Mississippi River; across the river is the Mississippi Bottoms, a flat area which is about the elevation of the river. Early morning temperature inversions occur in this central river valley on about 65 percent of the days, caused by topography and meteorological conditions.

a. Metropolitan St. Louis Interstate AQCR



b. St. Louis Metropolitan area

Figure 1. Location of St. Louis Metropolitan area

Because of its location in the Great Plains, St. Louis experiences the movements of air masses through the area. From the north in Canada come cold air masses and from the Gulf of Mexico in the south comes warm, moist air. Where the frontal zones come together, they produce a variety of weather conditions.

The climate in St. Louis is moderate - the winter is mild, spring and autumn are warm, the summer tends to be hot. The coldest month, December, averages 30 degrees, and the warmest month, July, averages 78.7 degrees. The average number of heating degree days, 4,750, and the average annual precipitation, 36.6 inches, are also moderate. The prevailing wind is from the south during summer and autumn and from the northwest during winter and spring.

Land Use and Employment Patterns

St. Louis is the largest city in Missouri and the tenth largest in the United States. The city's population is 581,000 and the population of the metropolitan area is 2,454,000. The St. Louis Metropolitan Area is highly industrialized, as the figures in Table 1 show. About 35 percent of nongovernment employment in the AQCR is in manufacturing. St. Louis is second in the nation in auto assembly and is the home of McDonnell-Douglas, the aircraft manufacturer, and Anheuser-Busch, the world's largest brewer. There is also a large grain market. Table 2 shows that the principal manufacturing products are transportation equipment, primary metals, fabricated metal products, food products, and machinery.

The central business district of the City of St. Louis is located on the Missouri shore of an eastern bend in the river. Industry lines the river along both shores from south of the city to the industrial areas of Alton and Wood River in Illinois to the north. On the Missouri side of the river, land use is densely residential around the central business district and industrial areas of the city west of the river, and becomes increasingly less densely populated beyond the city-county line into the rural areas

Table 1. NONGOVERNMENT EMPLOYMENT IN AQCR

Agricultural services, forestry, fisheries	2,000
Mining	4,000
Contract construction	40,000
Manufacturing	279,000
Transportation, public utilities	52,000
Wholesale trade	58,000
Retail trade	146,000
Finance, insurance, real estate	5,000
Services	162,000
Total	798,000

Table 2. MANUFACTURING EMPLOYMENT IN AQCR

Transportation equipment automobiles and aircraft	59,000
Fabricated metal products	25,000
Primary metals	22,000
Machinery	20,000
Food processing	19,000
Printing and publishing	18,000
Other	116,000
Total	279,000

of the western part of St. Louis County. Along the Illinois shore, the land use is industrial but the population density is not as high and there is more open space than on the Missouri side of the river.

AIR QUALITY PATTERNS AND TRENDS

The hi-vol samplers in the St. Louis area are operated by three different agencies. The St. Louis County Air Pollution Control Division has 10 particulate monitoring sites in St. Louis County, the St. Louis City Division of Air Pollution Control runs 12 monitoring sites, and the Illinois EPA runs 14 sites in Madison and St. Clair Counties. The monitoring sites are mostly clustered in and around the City of St. Louis and its suburbs but several are located in the industrial areas of Granite City and Alton, Illinois, and one is remote. Figure 2 shows the locations of the monitoring sites and Table A-1 in the Appendix contains information about them. The monitors range in height from 4 to 60 feet; most are in the range of 10 to 40 feet in height. Seventeen of the monitors are in industrial locations, nine are in commercial areas, six are residential, and one is in a remote location.

The 1974 annual geometric mean TSP concentrations are shown at their respective sampling sites in Figure 3. TSP concentrations ranged from 40 $\mu g/m^3$ at the remote site to 50 to 70 $\mu g/m^3$ at the residential sites, 60 to 80 $\mu g/m^3$ at the commercial sites, and generally over 80 $\mu g/m^3$ at the industrial sites.

The national particulate standards were exceeded at most of the 33 sites which were operated in 1974 (see Table 3). The annual primary standard of 75 $\mu g/m^3$ was exceeded by 16 of the sites and the annual secondary standard, 60 $\mu g/m^3$, was exceeded by 10 other sites. The 24-hour primary standard (260 $\mu g/m^3$) was exceeded on 16 sampling days (1.1 percent) and the 24-hour secondary standard (150 $\mu g/m^3$) on 131 sampling days (8.7 percent).

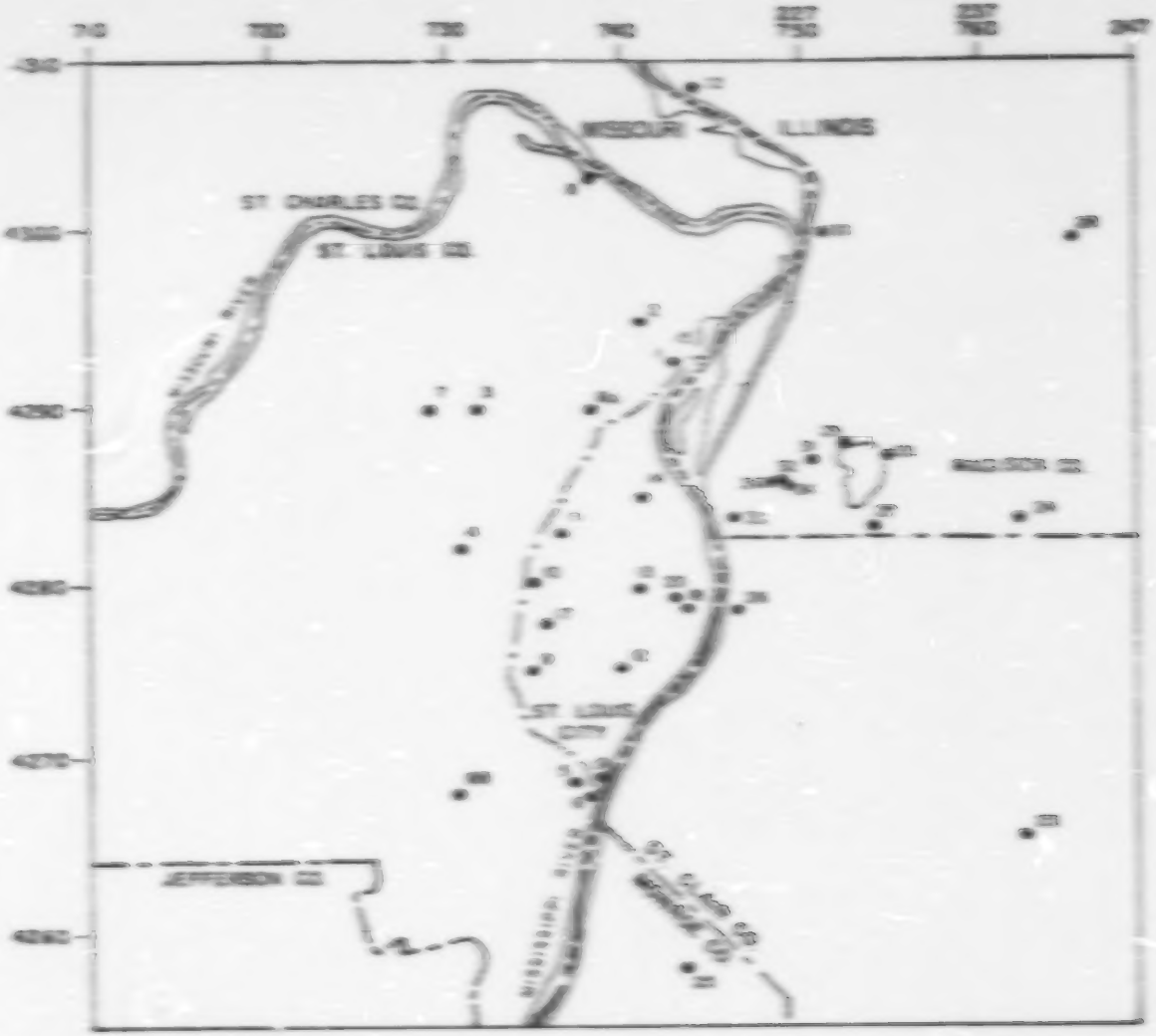


Figure 2. Locations of sampling sites

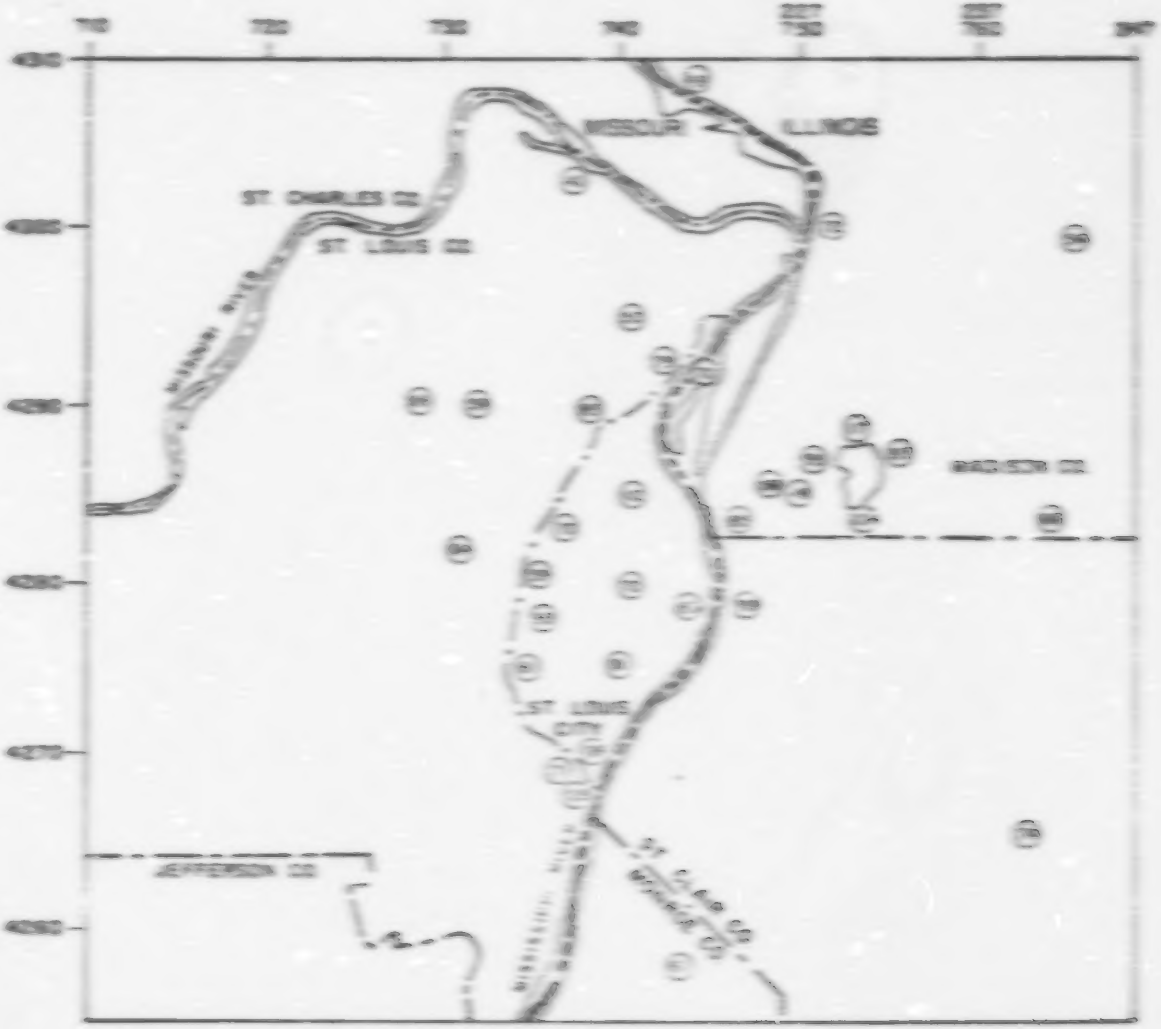


Figure 1. 1974 geometric mean TSP concentrations

Table 5. SAMPLING SITES AND NATIONAL STANDARDS

	Site number	Site name	1974 geometric mean TSP	24-hour violations	
				150 $\mu g/m^3$	260 $\mu g/m^3$
Industrial	1	Bellefontaine Neighbors	78[a]	1	0
	5	Lemay Mt. St. Rose Hosp.	71[a]	1	0
	6	Lemay-ACIC	128[a]	16	6
	14	Shreve Rd., City	112[a]	11	2
	15	Chain of Rocks, City	70[b]	0	0
	17	River des Peres, City	91[a]	6	0
	19	8227 S. Broadway, City	126[a]	41	6
	22	Alton	69[b]	1	0
	26	E. St. Louis, City Hall	89[a]	3	0
	29	Granite City, City Hall	117[a]	5	0
	30	Wood River	72[b]	0	0
	31	Granite City, Lake School	85[a]	-[c]	-[c]
	32	Granite City, 3001 E. 20th	138[a]	-	-
	33	Granite City, Fire #1	93[a]	-	-
	34	Granite City, 15th & Madison	118[a]	-	-
	35	Granite City, Fire #2	85[a]	-	-
Residential	2	Bellefontaine Neighbors	50	0	0
	3	Berkeley	59	1	0
	4	Clayton	66[b]	1	0
	9	4400 Bonhomme St., City	61[b]	0	0
	10	Forest Park, City	59	0	0
	11	1400 Shaumut, City	70[b]	1	0
Commercial	7	St. Ann	65[b]	1	0
	8A	Jennings	85[a]	-	-
	12	1300 S. Grand, City	81[a]	1	0
	13	St. Louis Univ., City	70[b]	1	0
	18	Muni., Courthouse, City	80[a]	1	0
	23	P.O. Building, City		2	0
	27	Belleville	74[b]	2	0
	24	Collinsville	60[b]	0	0
	28	Edwardsville	54	0	0
Remote	8	Old Jamestown Rd.	40	0	0

[a]Violates the annual primary standard in 1974.

[b]Violates the annual secondary standard in 1974.

[c]Not available.

The averaged TSP trends for all monitors operating before 1969 are shown for the three agencies in Figure 4. Seven sites in St. Louis County had an average decrease of 21 ug/m^3 from 1968 to 1974; four sites in St. Louis City showed an average decrease of 73 ug/m^3; and 12 sites in Madison and St. Clair Counties decreased an average 50 ug/m^3 from 1969 to 1974. The largest annual decreases occurred from 1969 to 1970.

The longest operating site is the NASN site in downtown St. Louis (site 20). Figure 5 shows the raw data for the monitor since it began in 1957. A curve has been drawn smoothing the data in order to show the long-term trend which has been downward from about 160 ug/m^3 in 1957 to about 80 ug/m^3 in 1974.

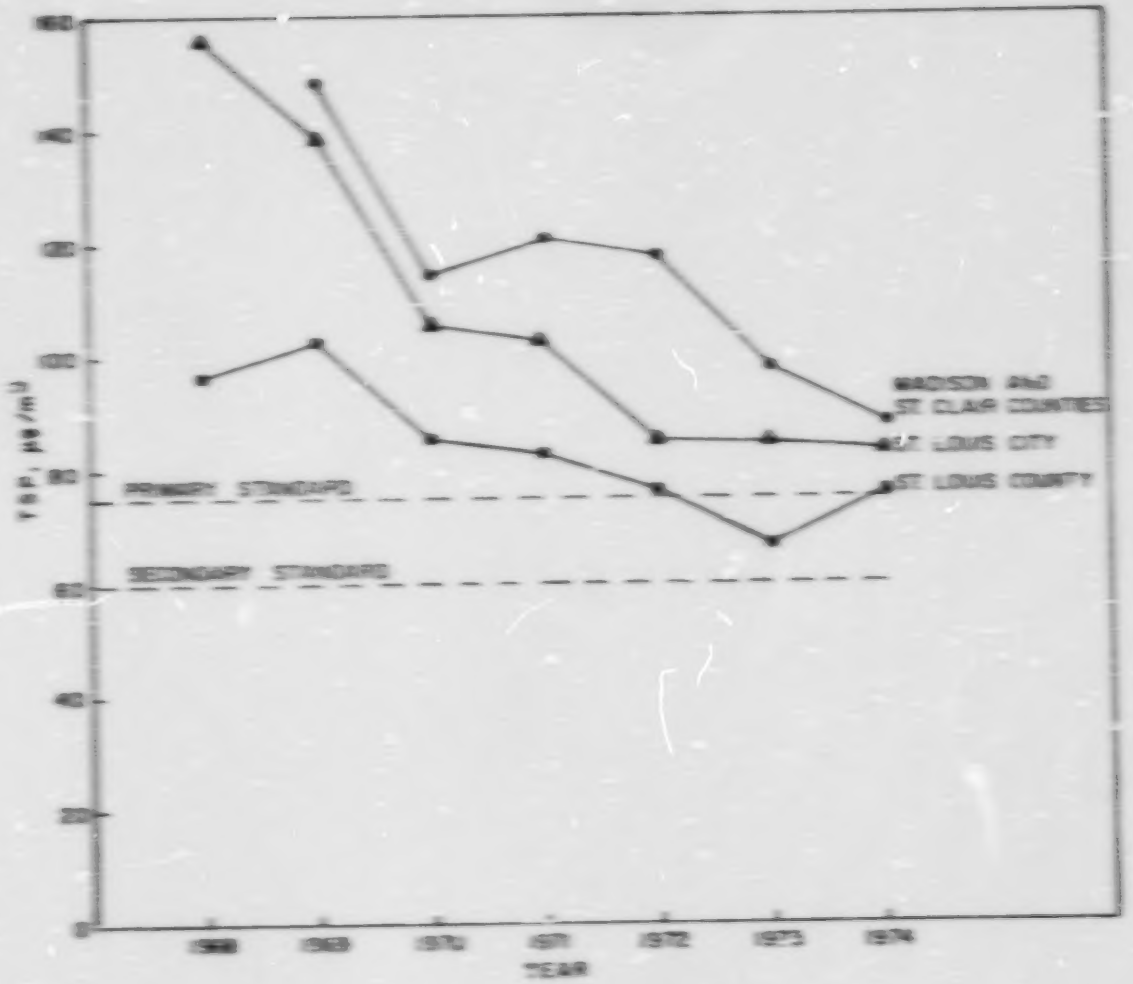


Figure 4. TSP trends in St. Louis City, St. Louis County, and Madison and St. Clair Counties

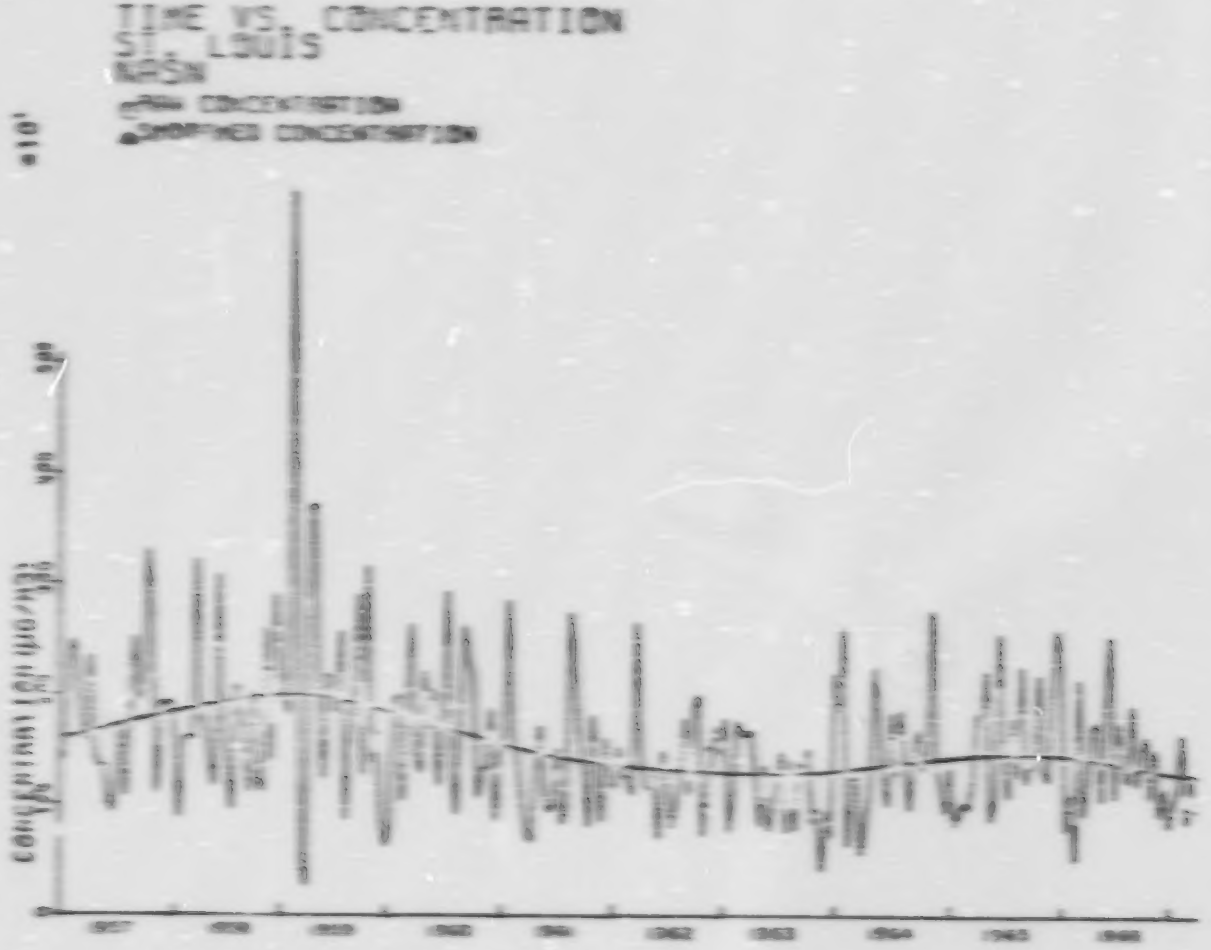


Figure 5. NASN site TSP trend

SECTION II

ANALYSES

EMISSIONS

Emission Inventories

The St. Louis Metropolitan Area, because of its central location in the nation, has become a center of transportation and industry. The principal products are fabricated metals, primary metals, transportation equipment, food products and machinery. The industries in St. Louis County are, for the most part, small, clean industries located in small industrial parks which are scattered in the county, resulting in a low density of industry. St. Louis City and Madison and St. Clair Counties are characterized by heavy industry much of which is located along the Mississippi River.

The most recent emission inventories for particulates are from 1973 and are shown in Tables 4 and 5. According to the NEDS inventory (Table 4), the greatest amount of particulate emissions occur in Madison County, Illinois, and over all four counties, the greatest amount results from industrial processes, primarily, and industrial and utility fuel combustion. Madison County accounts for 80 percent of the particulate emissions and is followed by St. Clair County (8 percent), St. Louis City (7 percent), and St. Louis County (5 percent). Industrial process emissions far outweigh the contributions from other sources - 73 percent versus 14 percent for utility fuel combustion. According to the emissions inventories compiled by the air pollution control agencies of St. Louis City and St. Louis County

Table 4. 1973 EMISSIONS INVENTORY FOR ST. LOUIS METROPOLITAN AREA - NEDS (in tons/year)

	St. Louis City	St. Louis Co.	Madison Co.	St. Clair Co.	Total
Fuel combustion	20,796	7,234	44,766	10,971	83,767
Residential	220	360	413	535	1,528
Industrial	17,431	2,933	3,511	10,117	33,992
Utility	3	3,749	40,695	173	44,620
Other	3,142	192	147	146	3,627
Industrial process	1,328	8,317	237,521[a]	14,063	261,229
Solid waste disposal	1,018	44	974	741	2,777
Transportation	1,564	4,401	1,228	1,380	8,570
Total	24,705	19,997	284,485	27,161	356,348

[a]This estimate for Madison County appears excessive.
Source: NEDS.

Table 5. 1973 EMISSIONS INVENTORY FOR ST. LOUIS AREA, IN TONS PER YEAR

	St. Louis City[a]	St. Louis Co.[b]	Madison Co.[c]	St. Claire Co.[c]
Fuel combustion	4,930	6,343		
Residential	3,570	543		
Industrial		959		
Utility	1,360	4,590	Detailed	Detailed
Other		251	inventory	inventory
Industrial process	9,010	8,317	not	not
Solid waste disposal	1,700	66	available[d]	available[d]
Transportation	1,360	2,897		
Total	17,000	17,623	42,659	17,158

[a]Source: St. Louis City Air Pollution Control Progress Report, 1973.
[b]Source: St. Louis County, Air Pollution Control Division.
[c]Source: Illinois EPA, 1973.
[d]1974 Point source inventory: Madison 37,871 TPY, St. Claire 17,158 TPY.

and the State of Illinois (Table 5) which are more current than NEDS, the important sources of particulates are fuel combustion and industrial process emissions.

Comparing the estimates of St. Louis County emissions, the NEDS inventory shows higher estimates for industrial fuel combustion and transportation emissions but the overall estimates are not very different. The St. Louis City emissions, however, are quite different between the two tables - fuel combustion emissions are four times higher in the NEDS inventory and industrial process emissions are six times higher in the agency inventory. The Illinois inventory is substantially lower than NEDS, especially for Madison County.

The reliability of the inventories is questionable since the local and NEDS inventories differ substantially in some respects and since the NEDS inventories for the Illinois counties may be outdated and are probably overestimating industrial process emissions in Madison County. The agency inventories are considered more reliable than the NEDS inventories.

Though the reliability of the inventories is questionable, the conclusions that can be drawn from them seem reasonable - that point sources, especially industrial processes and industrial and utility fuel combustion, are the major sources of particulate emissions, that area source emissions are small in comparison, and that Madison County, where several steel mills are located, is responsible for much of the particulate emissions. The influence of these factors on TSP air quality can be seen by studying patterns of TSP concentrations. In a comparison of TSP concentrations by the day of week on which they were recorded (Figure 6), TSP concentrations were found to be lower on weekends than on weekdays - 75.0 $\mu g/m^3$ versus 92.9 $\mu g/m^3$ - implying that industrial activities occurring on weekdays are responsible for the higher weekday TSP concentration. A map of the 1974 mean TSP concentrations (Figure 3), when compared with the locations and emissions of the major industries in the St. Louis area (Figure 7), shows that TSP concentrations over 100 $\mu g/m^3$ were recorded in the industrial areas in Granite City, Illinois (sites 27, 29, 32 and 34), and

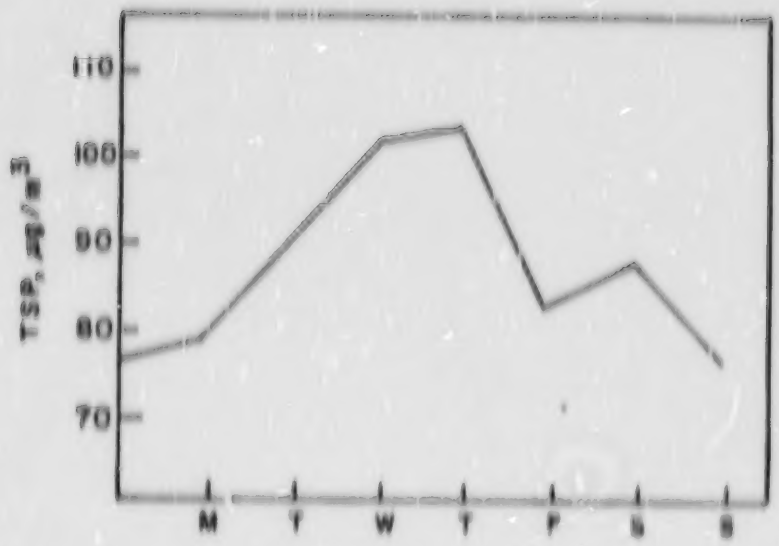


Figure 6. 1974 average TSP concentrations in St. Louis City by day of week

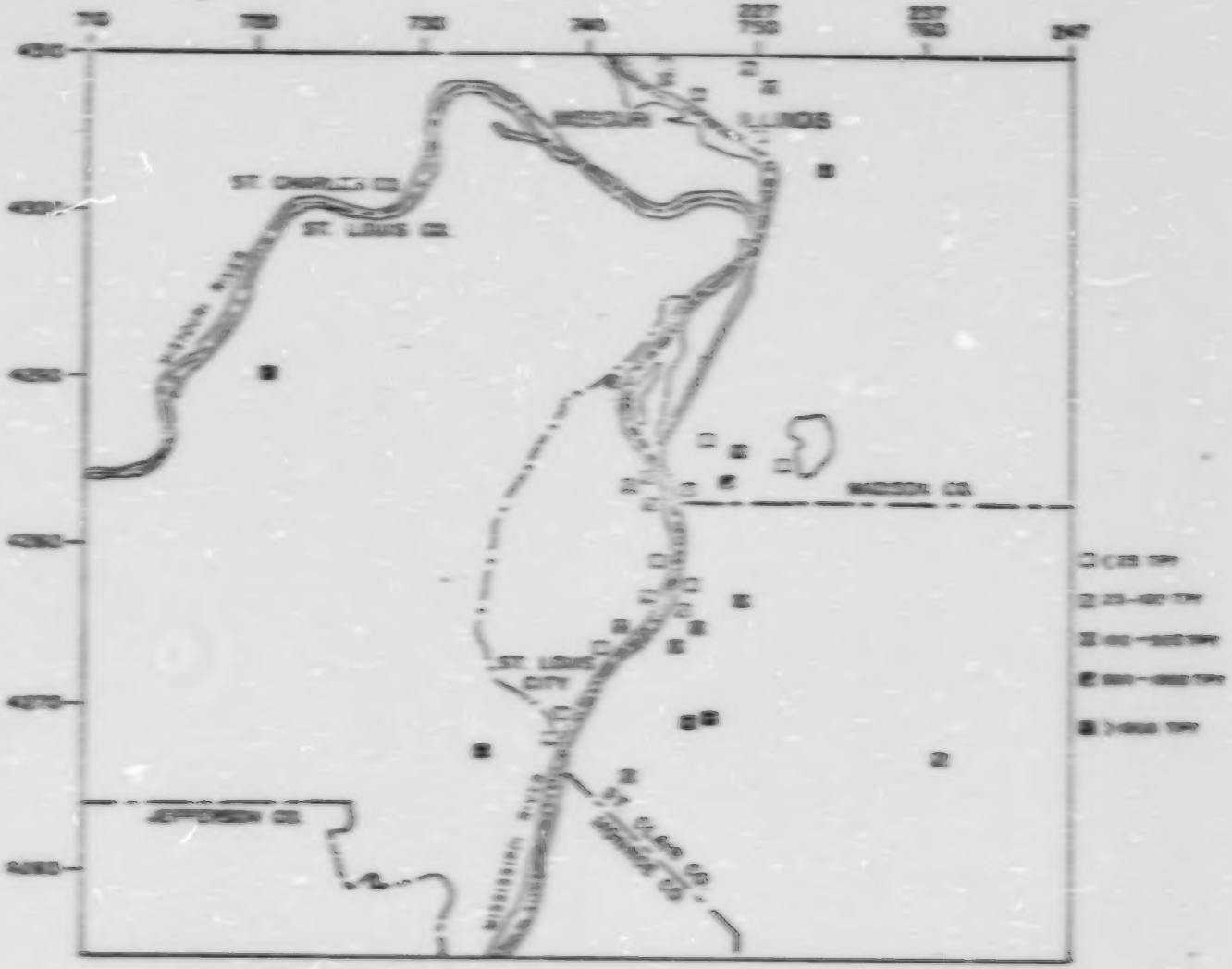


Figure 7. Locations and emissions of major point sources

at the southern tip of St. Louis City (sites 6 and 19). High TSP concentrations were also recorded in the industrial areas along the Mississippi River (sites 14, 15, 18, 26 and 35).

Emissions Modeling Study

St. Louis air quality was modeled in a study performed by the U.S. Environmental Protection Agency to assess the attainment of the TSP standards. The study[1] was based on NEDS data in the Missouri study area. The NEDS inventory in Illinois was adjusted to account for ongoing compliance of sources. The model calculated for 1972 and 1975 the TSP concentrations at various sampling sites and the contribution of the source categories provided by emission inventories to these concentrations. The 1975 emissions inventory used was based on the 1972 inventory and reports that compliance would be complete by 1975 on the Missouri side and almost complete on the Illinois side. Since fugitive emissions and fugitive dust emissions were not provided in the inventories, the model calibration and results are based on the assumption that such emissions are at a constant level throughout the area and, thus, part of the background. The intercept of 1972 actual and modeled TSP concentrations was used as the background level in the study - the intercept was 35 $\mu g/m^3$.

The modeling results and analyses of them are presented in Table 6. The most important sources of TSP concentrations above the intercept are industrial processes and area sources. Industrial processes were the most important sources (greater than 40 percent) at the industrial sampling sites (sites B, C, H, I, and O), whereas area sources were most important (over 50 percent) at the residential and commercial sites (D, E, F, G, J, P and Q). The large contributions of industrial sources at several of the sites indicate that a considerable improvement in air quality might be accomplished if these sources were to reduce their emissions further.

Since the 1975 annual mean TSP concentrations were not available, 1974 data were used for a comparison with the 1975 predicted TSP concentrations

Table 6. [illegible]

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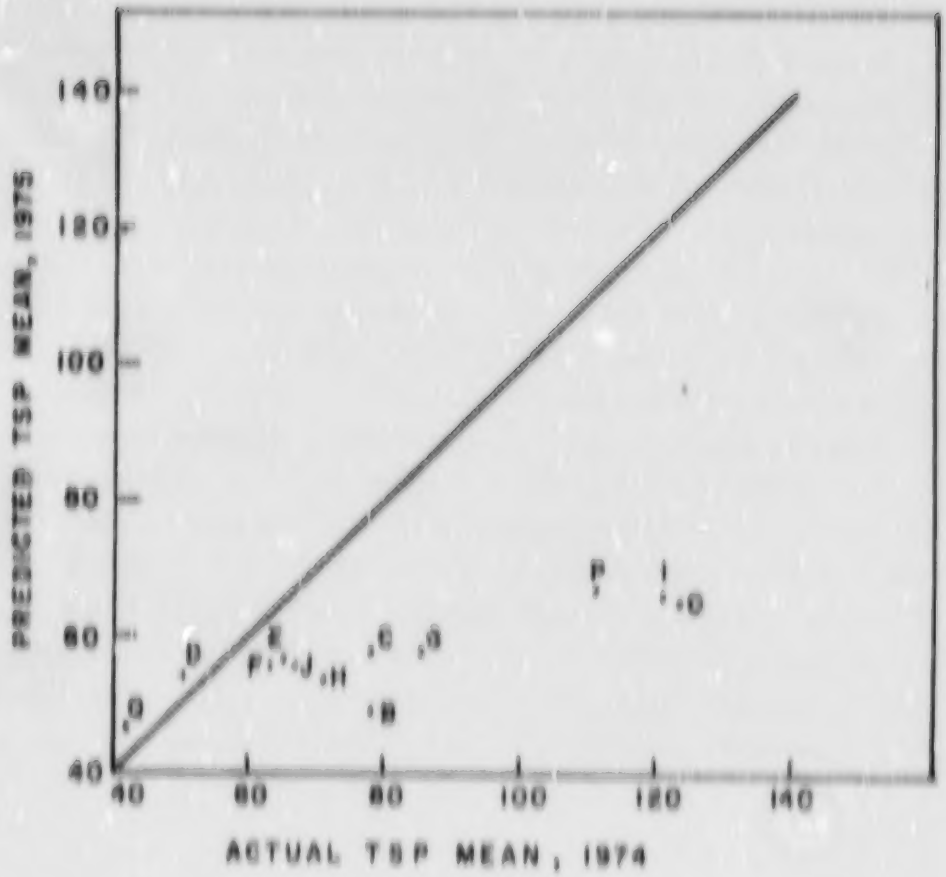

Figure 8. Actual versus predicted

in order to determine how well the model predicts. Unfortunately, little data for Illinois was available for calibration and comparison. Figure 8 and Table 6 show that the prediction error is small for six sites but large (greater than 25 $\mu g/m^3$) at the remaining six sites. These six were substantially underpredicted; these also were all of the sites which exceeded the annual primary standard. The model tends to underpredict as is shown by the six sites for which the prediction error is small - four of the six were underpredicted and only two were overpredicted. But the tendency to underpredict should account for only a small part of the prediction error; other factors are probably more influential as is shown in Table 5. There are some sources which are known to have been emitting fugitive emissions in 1974 and in 1975 such as the "hot spot" at the southern tip of the city. Also the incinerators at the St. Louis Housing Authority, the utility in the county burning solid wastes as an experimental fuel and smaller sources not in NEDS would contribute to the error. Uninventoried emissions - specifically fugitive dust and fugitive emissions - would also cause the model to underpredict air quality since these were assumed to be relatively constant throughout the area. In several areas of the city, however, fugitive dust and fugitive emissions are known to be present and are probably causing higher levels of TSP in a localized spot. MRI has recently conducted an extensive fugitive dust study in St. Louis for the RAPS study but its results were not available as yet.

Emission Trends

Particulate emissions have decreased considerably over time. The reductions in particulate emissions are the result of fuel switching, process and fuel combustion emission controls, new methods of solid waste disposal, and dust control.

Fuel switching has been occurring since the Second World War - see Tables 7 and 8. Coal combustion had been the major source of power and was gradually replaced by the cleaner fuels with less particulate emissions - natural gas and oil. The number of residences using coal dropped dramatically between 1950 and 1970 - whereas 60 percent of the dwelling units used coal in 1950, only 1 percent used coal in 1970. Fuel switching by industries and utilities has been more recent, much of it since 1967 in Missouri and since 1971 in Illinois. In the SMSA, consumption of natural gas by industries increased between 1963 and 1972 while consumption of oil, coal and coke fell. In the city, the utilities have been burning more oil and less natural gas and coal since 1964 and in Illinois, the utilities have been switching to natural gas from coal since 1971. The energy shortage, however, may force fuel switching to be reversed. Coal combustion will probably increase in the future and emission controls will be required in order to keep particulate emissions from increasing as a result.

Controls on fuel combustion and industrial process emissions have also been a part of the reductions in particulate emissions. It is believed that essentially all point sources in St. Louis City and St. Louis County have come into compliance with the regulations since 1967 when enforcement of the revised regulations began. In the areas in Illinois adjoining St. Louis, many sources have reduced emissions since 1972. It appears that emission reductions due to emission controls have been considerable but reliable inventories are not available for determining the degree of reduction or the effects of industrial growth since 1967.

Solid waste disposal practices have changed since 1967. Incinerators, large and small, have been closed or improved or replaced by alternative methods. In St. Louis City, 960 incinerators have been closed since 1967 and 120 have been upgraded. Some incinerators have been closed due to enforcement of the regulations, others because of the expense and trouble necessary to operate them correctly.

Table 7. 1950-70 RESIDENTIAL FUEL USAGE IN ST. LOUIS

Fuel	Number of dwelling units			Δ 1950-60 as % of 1950	Δ 1960-70 as % of 1950	Δ 1950-70 as % of 1950
	1950	1960	1970			
St. Louis SMSA						
Gas	101,960	345,631	606,779	+239	+ 256	+ 495
Oil	80,420	138,539	90,198	+ 72	- 60	+ 12
Coal	283,774	133,153	13,794	- 53	- 42	- 95
Electricity	575	2,010	20,467	+250	+3,210	+3,460
St. Louis City						
Gas	56,980	145,695	184,616	+156	+ 75	+ 231
Oil	43,130	41,199	16,949	- 4	- 57	- 61
Coal	142,375	59,365	3,375	- 58	- 40	- 98
Electricity	195	533	3,867	+173	+1,710	+1,883

Table 8. FUEL USAGE TRENDS IN ST. LOUIS

Fuel	Unit	Industrial usage[a]			Electrical utility usage[b]		
		1963	1972	% Δ 1963-72	1964	1973	% Δ 1964-73
Gas	10^6 ft^3	68,151	77,600	+14	8,881	114	-98
Oil	1000 bbl	1,431	804.6	-44	0.2	85	+42,400
Coal	1000 tons	1,819	907	-50	2,50.	1,619	-35
Coke	1000 tons	101	70.4	-30			

[a]Source: Census of Manufactures, 1963 and 1972. Fuels and Electric Energy Consumed. (Data are for SMSA level.)

[b]Source: Steam Electric Plant Factors Book, 1965 and 1974, National Coal Association, Washington, D.C. (Data are for City level.)

One of the utilities in St. Louis County has conducted an experimental program of using refuse as fuel. Emissions of particulate were greater during the experiment but will be reduced by emission controls when this becomes a more permanent arrangement.

St. Louis City and St. Louis County have been making efforts to control dust since 1967. This has included paving roads and lots, oiling dirt roads, and encouraging dust control by wetting at the quarries and cement plants. Street cleaning by the municipalities has also been a step toward this end.

TSP concentrations have been declining as particulate emissions decreased, see Figures 4 and 5. At the NASN site in St. Louis City, the TSP concentration decreased from about 160 ug/m^3 in 1957 to about 80 ug/m^3 in 1974, the largest decrease occurring after 1969. The averaged annual mean TSP concentrations have decreased most rapidly for sites in the city of St. Louis since 1968. The decrease has been more gradual for sites in St. Louis County. The decreases probably result from enforcement of the 1967 regulations - fuel switching, emissions controls, and incinerator shutdown and controls. The sites in Madison and St. Clair Counties experienced a large decrease from 1969 to 1970 which could be due to decreased emissions on the Missouri side and another large decrease from 1972 to 1973 from decreased emissions due to the new Illinois regulations.

REGULATIONS AND ENFORCEMENT

The St. Louis Metropolitan Area spans the Mississippi River, encompassing counties in two states - Missouri and Illinois. Several agencies, representing the states, cities, and counties, are involved in air pollution control in the metropolitan area and will be discussed in this section as parts of the overall air quality situation.

Institutional Framework

The metropolitan area is part of two EPA Regions. The Illinois side is in the jurisdiction of Region V which is based in Chicago, and the Missouri side is in Region VII which is based in Kansas City. In Missouri, the State Division of Environmental Quality is responsible for conducting an air pollution control program throughout the state except where it has delegated this authority to local agencies. The two local agencies in the St. Louis area are the Division of Air Pollution Control of the City of St. Louis and the Air Pollution Control Division of St. Louis County. Both were in existence prior to 1967 when the State of Missouri adopted air pollution regulations. These regulations allowed the local agencies to promulgate regulations that were at least as stringent as the state's regulations and to run their own air pollution control programs.

In Illinois, the Environmental Protection Agency (Illinois EPA) is responsible for air pollution control activities throughout the state. Field operations - source inspections and air quality monitoring - are conducted by regional offices of the Illinois EPA. In the St. Louis Metropolitan Area, the Region IV Field Operations office is in Collinsville in Madison County. Local agencies in some of the larger cities and counties are responsible for monitoring air quality. In the St. Louis area, the local agencies are in East St. Louis and Granite City.

Two other state agencies in Illinois have air quality functions. The Pollution Control Board promulgates regulations and conducts variance

hearings and hearings on violations. Long range studies, data processing and recommendations for changes are handled by the Illinois Institute for Environmental Quality.

Regulations

The City of St. Louis has had air pollution ordinances since 1893. These have been amended and revised many times. The most recent law was passed in 1967 in response to the findings of the Interstate Air Pollution Study of 1963 and was approved by the Federal Government. St. Louis County adopted air pollution regulations in 1967 as stringent as the city's regulations. The State of Illinois adopted its present air pollution regulations in 1972 but had some regulations prior to that time.

The regulations are summarized in Table A-2 in the Appendix. An overview of them shows that the Illinois regulations are generally more stringent than the national average and that the Missouri agencies' regulations are somewhat less stringent than the national average.

The emissions standards for industrial processes and for fuel combustion are shown in Figures A-1 and A-2. The Illinois process weight standard approaches maximum stringency while the Missouri standard is about average. The Illinois fuel combustion standard is about average and the Missouri standard is near minimum stringency.

The standard for incinerator emissions is strict for Illinois and about average for Missouri. The visible emissions standard for both is average for new sources but less than average for existing sources. The Missouri agencies' fugitive dust regulations which are average prohibit unnecessary emissions from materials handling and require that reasonable precautions be taken to prevent dust from becoming airborne. Illinois prohibits visible fugitive emissions from any process beyond the property line where they originated and restricts the size of particles crossing the property line.

Section 9-a of Illinois' Environmental Protection Act has been used by Illinois EPA for nuisance fugitive dust, and "hot spot" situations where it has proven to be very effective in reducing or eliminating emissions.

Enforcement and Compliance

St. Louis City and St. Louis County - Sources are inspected annually by the county agency for permits and maintenance of equipment; the larger and problem sources are inspected more frequently. The city agency inspects sources every 3 months to 3 years, the interval depending on the nature of the source. It does not issue permits annually - only when there is a change in status. Both agencies maintain visual surveillance and respond to complaints. The state agency occasionally makes unannounced inspections to check on the agencies' enforcement.

If necessary, the City agency can take a company directly from a written violation to court. Abatement orders combining several violations can be issued for a specified time period. Enforcement matters are handled by the agencies in local courts; additional suits may be brought by the state and federal governments if they feel it is necessary but this happens infrequently.

Since the regulations came into effect in 1967, the air pollution agencies in both St. Louis City and St. Louis County have worked to get the sources of air pollution into compliance with the regulations. The agencies have a good working relationship with industry. Most companies were cooperative. Few cases were taken to court and none were lost by the air pollution agencies. Some smaller companies had problems implementing controls and coming into compliance. The air pollution control program resulted in more efficient collection devices, switching from coal to oil and natural gas, the closing of residential and municipal incinerators, an open burning ban, and efforts to control some sources of fugitive dust.

At present, it is believed that almost all sources in St. Louis City and St. Louis County are in compliance with the regulations. Several factors which influence emission levels, however, should be taken into consideration. First, a number of sources, some of them large, are not yet in compliance. The St. Louis Housing Authority still operates about 75 single chamber flue-fed incinerators and is being taken to court concerning this. The Union Electric power plant has been burning refuse as an experimental fuel and its particulates emissions have been above the standards but these will be reduced. At the southern tip of the city on the city-county boundary is a "hot spot" where two industries, a carbon coking plant in the city and a chemical company in the county, are causing high TSP concentrations. The State has a hot spot regulation which would help alleviate this situation.

Stack tests are generally performed only when new equipment is installed. Emissions are usually calculated and walk through inspections are performed.

Finally, the regulations themselves are not as stringent as they might be. The fuel combustion emissions and incinerator emissions regulations are less than average in stringency; and the visible emissions regulation for existing sources allows 40 percent opacity. Even if compliance were complete, further reductions in emissions and thus an improvement in air quality could be reasonably obtained by increasing the stringency of the regulations. The amount of the decrease would require more detailed analysis since some sources may have reduced emissions below the level required in the present regulations.

Illinois - The Illinois EPA has been working to get new cases of air pollution into compliance since the regulations were adopted in 1972. Most companies have been cooperative and most are now in compliance or on a compliance schedule.

The Region IV Field operations office has divided the seven county region into districts, each with a district engineer who is responsible for inspecting and knowing all industries within the district. Inspections are made twice a year, more frequently for larger and problem sources, and in response to complaints. Variance hearings are held before the state's Pollution Control Board - variances are given only when a compliance schedule has been worked out and a performance bond has been posted. The performance bond, which is the cost of the control equipment, is forfeited to the state if the company has not met its compliance obligations. A stack test is performed after the control equipment is installed to ensure compliance.

METEOROLOGY AND CLIMATOLOGY

Inversions

The St. Louis Metropolitan Area lies in the Central Plains Region which experiences a continental type climate - rapid changes in daily temperature, summers which tend to be long and hot with frequent storms, winters which tend to be short, cool, and dry. As a result, inversion frequencies in St. Louis are related to the diurnal cycle and the season - see Table 9. Inversions frequently occur at night but there is generally good dispersion during the day. Inversions occur more frequently during the fall and winter seasons because of the minimum storminess in the fall and the maximum length of a stable nocturnal period in winter.

Table 9. FREQUENCY OF INVERSIONS IN ST. LOUIS, PERCENT

	9 pm	9 am	Total time
DJF winter	63	24	37
MAM spring	60	11	27
JJA summer	82	7	34
SON fall	81	13	44

Source: C.R. Hosler. Low Level Inversion Frequency in the Contiguous United States. Monthly Weather Review. 89:319. Sept. 61.

St. Louis is located beside the Mississippi River near its confluence with the Missouri River. The river valley, though shallow, is sufficient to induce frequent inversions. Early morning temperature inversions occur in the central river valley on about 65 percent of all days, caused by topography, the tendency toward nocturnal inversions, and the heat island effect. The heat island effect of the center city results in the warmer

air over the center city rising during the night and cooler air from outlying areas moving in to replace it. The river valley inversions trap the pollutants emitted by the many industries which are located along the river, thus increasing the already high concentrations of TSP and other pollutants.

Table 9 shows that there is a seasonal pattern with respect to inversion frequency - inversions occur somewhat more frequently during the fall and winter. The seasonal pattern of TSP concentrations during 1974, however, does not correspond to the frequency of inversions - concentrations are slightly higher during spring and summer (see Figure 9). The poor dispersion resulting from inversions is a relatively constant influence on TSP air quality in St. Louis throughout the year. But it appears that the frequency of inversions does not determine the seasonal pattern of TSP concentrations.

Climatology

Because of its location, St. Louis experiences frequent migrations of low pressure systems but infrequent stagnations of large high pressure systems. St. Louis is far from any natural barriers which might hinder the large scale movement of air masses through the area. From the south comes warm, moist air from the Gulf of Mexico and from the north comes cold, dry air from Canada. Storm systems move through the area most frequently during the winter and spring months.

The climate in St. Louis is moderate - the average number of heating degree days is 4750 and the average annual precipitation is 36.6 inches. The annual and 1974 monthly degree-day trends are shown in Figures 10 and 11 and the annual 1974 monthly precipitation trends in Figures 12 and 13. The number of degree-days in a year or a month indicates how much space-heating is occurring and thus, how much fuel combustion resulting in particulate emissions is occurring. Since rainfall tends to wash particulates out of

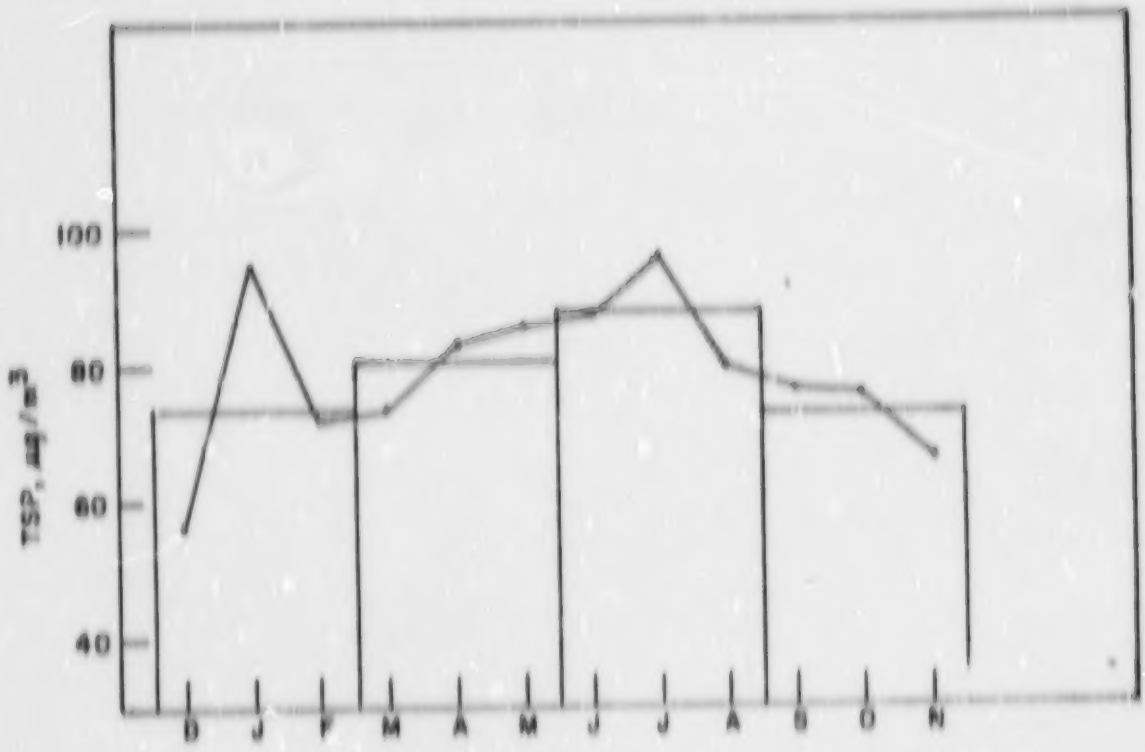

Figure 9. Seasonal pattern of averaged citywide TSP concentrations in 1974

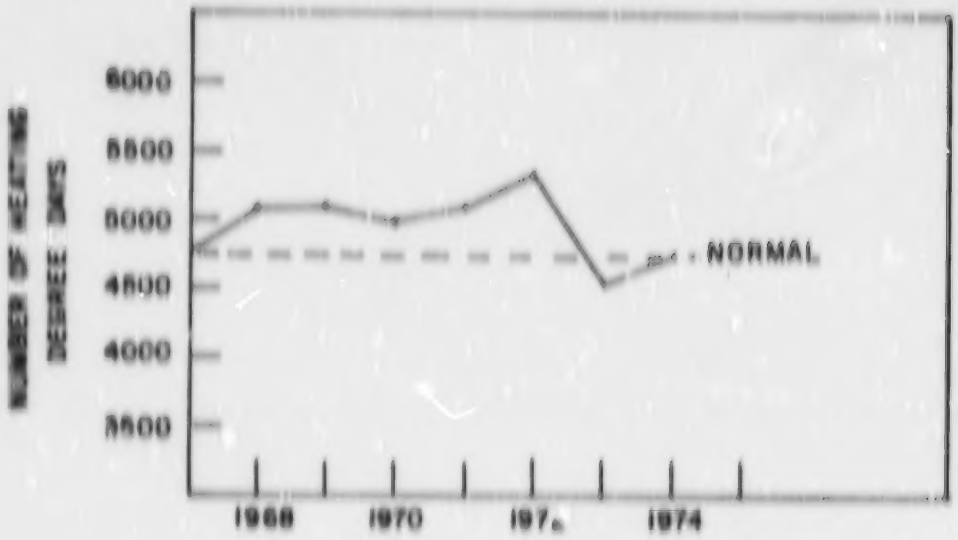

Figure 10. Trends in annual degree-days

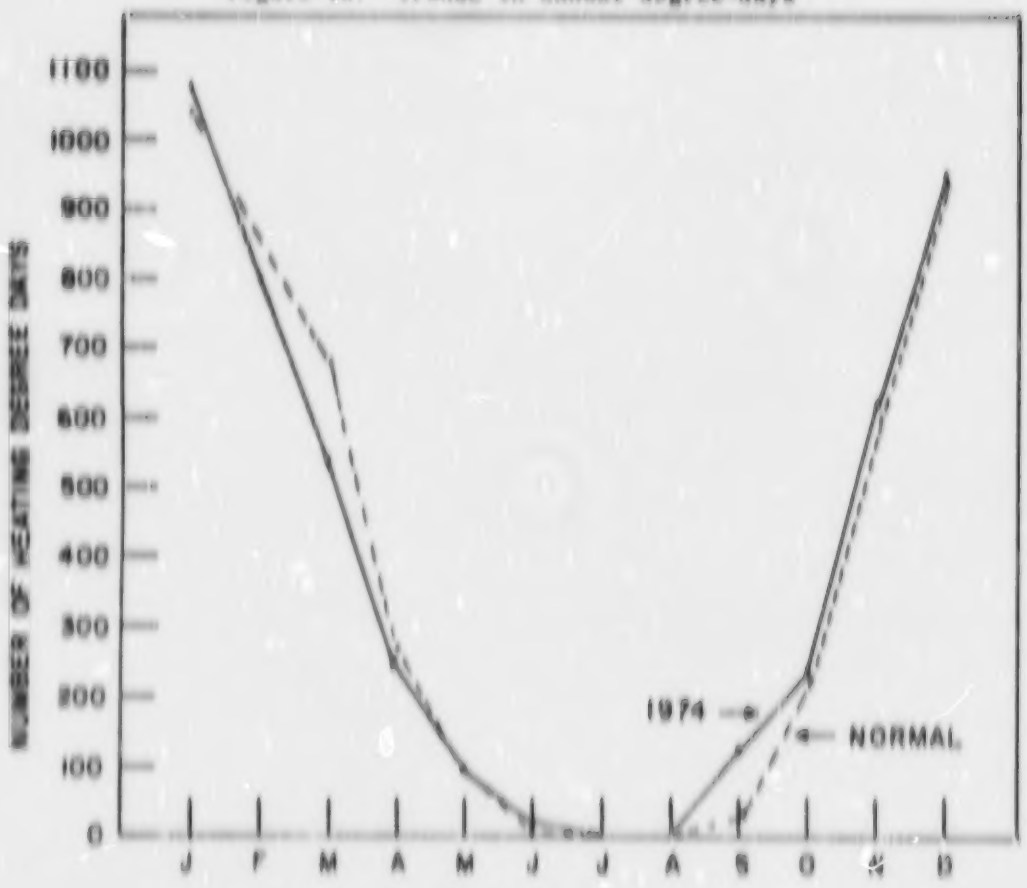

Figure 11. Trends in monthly degree-days

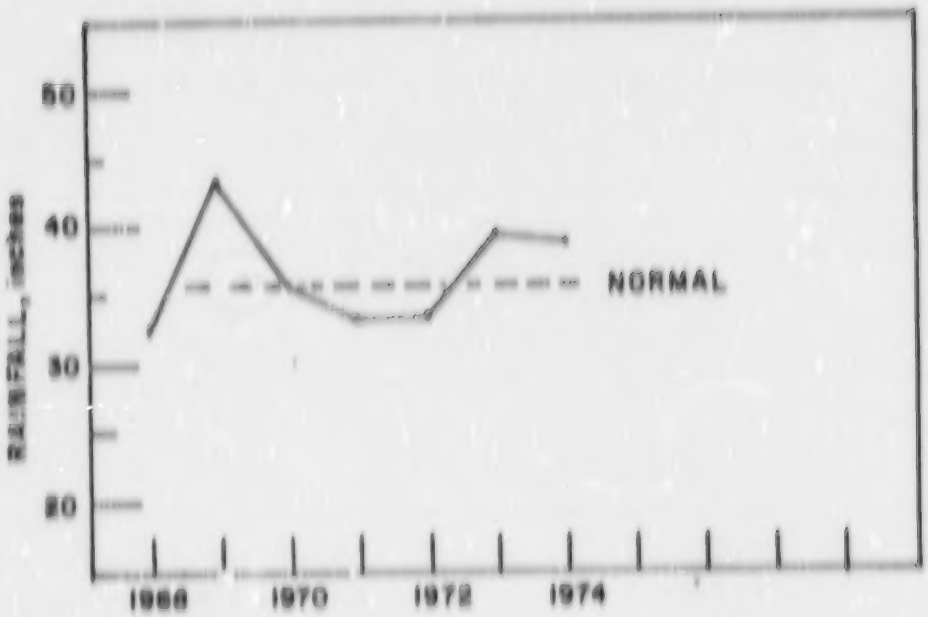

Figure 12. Trends in annual rainfall

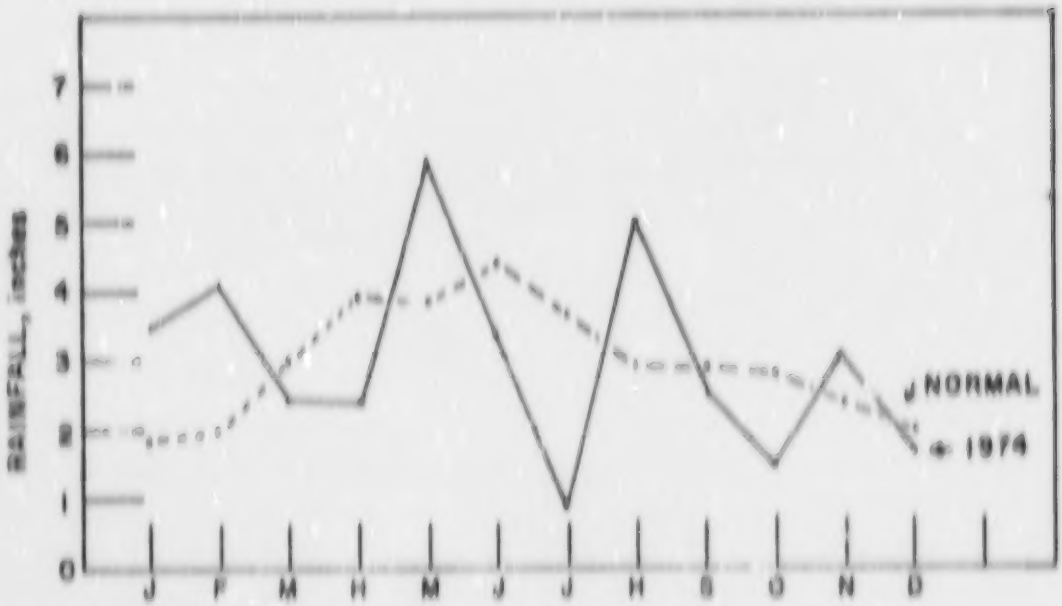

Figure 13. Trends in monthly rainfall

the atmosphere and to suppress the resuspension of dust, the amount of rainfall in a year or a month may indicate whether or not TSP removal is important.

The annual TSP trend since 1968 (Figure 6) has been generally downward. In contrast, the annual number of degree-days since 1968 has been greater than normal, except for 1973 and 1974; the annual rainfall was greater than normal in 1969, 1973 and 1974. So it appears that these trends in degree-days and precipitation are not related to the TSP downward trend since 1968.

The monthly TSP trend in 1974 (Figure 9) showed that higher TSP levels occurred during January and the warmer months. Monthly precipitation in 1974, however, was above normal in January, February, May and August and considerably below normal in July. The monthly TSP trends do not correspond to the precipitation and degree-day trends, except for the lower rainfall in July which could have been partially responsible for the high TSP levels that month.

In general, then, precipitation and degree-days are not responsible for TSP trends though they are known to influence TSP concentrations. Since fuel switching has been occurring and coal is now little used for space heating, the contribution of space heating is minimal and a correlation between degree-days and TSP is not expected.

Transport

Long-range transport of particulates into the area by the large scale movement of air masses influences the TSP concentrations in St. Louis. Air masses from the north consist of fresh polar air whereas air masses from the south are older and consist of warm, moist air which has picked up particulates in its trajectory over the southern states. The area surrounding St. Louis is generally rural and agricultural - particulates generated by agricultural practices probably influence air quality in

St. Louis. It is not possible, however, to determine from the available data how much long-range transport of particulates contributes to the TSP concentrations recorded in St. Louis.

Short range transport of particulates within the metropolitan area also occurs. Particulates emitted by industries affect the TSP concentrations recorded at downwind sampling sites. A pollutant rose shows the contributions of different wind directions to the total TSP concentration recorded at a sampling site. The pollutant roses for sites 15 and 19 in St. Louis City show the effects of the industrial emissions in the area to the southeast to southwest of the monitors - Figures 14 and 15. Thus industrial particulate emissions are probably influencing TSP concentrations throughout the city.

Figure 14. Pollutant rose - site 15, Chain of Rocks Water Department

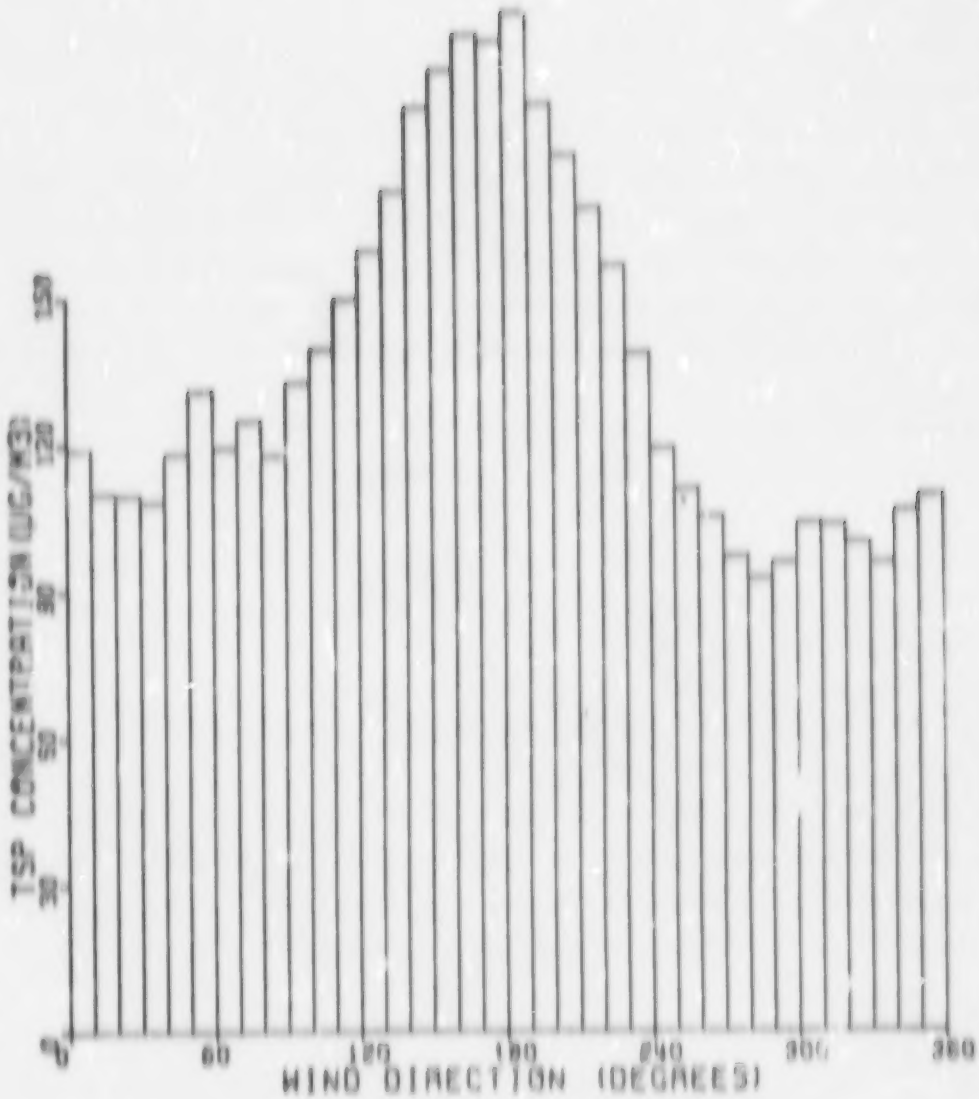

Figure 15. Pollutant rose - site 19, Fire House, South Broadway and Hurck

PARTICLE CHARACTERIZATION

For most of the study cities members of the GCA study team acquired hi-vol filters from the 1974 filter banks of the cognizant local agencies. In addition, several filter samples for 1974 and selected earlier years were obtained from state and federal filter banks. Although some filters underwent chemical and/or detailed physical analysis, the principal purpose of obtaining filters was to utilize optical microscopy to identify each of the constituents that comprised more than five percent of the particulate mass. The selected filters, which were representative of several different site types and TSP levels within each study area, were returned to a clean room at GCA/Technology Division and carefully inspected for artifacts and evidence of sampler or filter malfunctions.

Each filter was then assigned a randomly generated five digit number which served as the only identifier for the filter sample so that each analyst had no information concerning the city, site, TSP loading or probable local sources associated with the sample. Furthermore, the use of two laboratories for the microscopy, coupled with the randomly generated identifying numbers, permitted a fairly comprehensive quality control program in the form of blind replicate analyses. Since both laboratories utilized more than one analyst, these procedures resulted in as many as four microscopists observing samples from the same filter and, in some cases, the same analyst examining replicate samples from the same filter as many as three times.

The results of this quality control effort, which are presented in Volumes I and XVI, warn against relying very heavily on the results of any one filter analysis. However, the random match-up between analyst and filter sample should minimize systematic bias in composited results.

A total of 36 filters from six sites in St. Louis were selected for microscopic examination. The meteorological data from St. Louis International Airport for the days of interest are shown in Table 10.

Table 10. METEOROLOGICAL DATA ON SELECTED SAMPLING DAYS (INTERNATIONAL AIRPORT, ST. LOUIS)

Date	Precipitation (in.)		Wind speed (mph)		Wind direction (deg)	
	Day of obs.	Preceding day	Average	Resultant	3-hour observation	Resultant
6/15/74	0	0	11.4	10.9	320, 280, 280, 310 310, 320, 320, 280	310
6/28/74	0	0	1.2	0.0	270, C, C, 90 C, C, C, C	C
7/16/74	0	t	6.6	6.4	50, C, 20, 60 70, 70, 70, 60	60
10/08/74	0	0	4.5	4.4	C, C, C, 220 220, 220, 230, 230	220
11/07/74	0	t	4.2	2.4	C, 250, 280, 280 290, 250, 150, 140	250
11/19/74	t	t	9.4	4.7	150, 170, 130 140 190, 170, 250, 300	190

Note: C = Calm
t = Trace

Table 11 presents the results of microscopic examination by site for each of the filters. A brief characterization of each site and its location may be found in Table 3 and Figure 2. The results at each site have been averaged to give a composite of the particulate composition as shown in Table 12. Three filters underwent replicate analyses and the results are presented in Table 13.

The composite particulate characterization for all filters from St. Louis that underwent routine analysis, presented in Table 14, shows that three quarters of the particulate material is minerals and about one quarter is composed of combustion products. St. Louis ranks high compared to the other study cities (3rd out of 14) with respect to the percent mineral content, a somewhat perplexing observation considering the large amount of industry in the area. Although fugitive dust is implicated, the sources of the mineral material are likely varied and the relative contribution of these sources to TSP levels in St. Louis is not clear; the analyses implicate soil and road wear materials in some cases and in other cases they implicate raw material storage piles as the likely source(s). The relatively low levels of rubber found on the filters could seem to contraindicate extensive contributions from vehicular reentrainment. In addition, the microscopists oftentimes observed large amounts of mineral material associated with combustion products. This observation would seem to implicate sources such as steel mills and foundries.

In July 1975 the Atmospheric Aerosol Research Section of EPA conducted a special ambient air sampling program in St. Louis. This study included both conventional and novel sampling and analysis procedures. Daily TSP levels were monitored with conventional hi-vols while special instrumentation allowed determination of 18 metals at 3-hour intervals, the size distribution of particulates as a function of wind direction, and the corresponding elemental composition of the size fractionated samples.

Table 11a. RESULTS OF FILTER ANALYSES FOR SELECTED SITES IN ST. LOUIS AND VICINITY (MUNICIPAL COURT – NO. 8)

Date	16 June 1955			28 June 1955			14 July 1955			5 October 1955			7 November 1955			14 November 1955		
TSP ($\mu g/m^3$)	91			189			79			134			111			72		
Components	Number of particles	Size range, μ	Mean size, μ	Number of particles	Size range, μ	Mean size, μ	Number of particles	Size range, μ	Mean size, μ	Number of particles	Size range, μ	Mean size, μ	Number of particles	Size range, μ	Mean size, μ	Number of particles	Size range, μ	Mean size, μ
Quartz	(10)	1–42	7	20	1–84	12	10	1–42	7	11	1–42	9	14	1–47	7	14	1–44	7
Quartz	1			4			1			2			2			2		
Calcite	4			2			4			–			4			3		
Feldspars	2						2											
Hematite	1			2						2			2					
Mica																		
Combustion Products	(24)			(14)	1–48	3	(2)	1–42	3	(24)	1–28	3	(2)	1–24	3	(24)	1–44	3
Soot:																		
Oil																		
Coal																		
Coke				2			2			2			2			4		
Cokers													2					
Fly ash																		
Incinerator																		
Fly ash																		
Burned wood																		
Burned paper																		
Vegetation																		
Fungoid	(24)			(24)			(24)			(24)			(24)			(24)		
Pollen																		
Fibers																		
Paper																		
Starch																		
Wax, grease																		
Cotton																		
Spore fragments	(24)			(24)			(24)			(24)	1–42	22	(24)	1–42	20	(24)		
Iron or rust																		
Rubber										2			2					

Table 11b. RESULTS OF FILTER ANALYSES FOR SELECTED SITES IN ST. LOUIS AND VICINITY
(S. BROADWAY FIRE HOUSE – NO. 19)

Date	19 June 1953			25 June 1953			26 June 1953			8 October 1953			7 December 1953			14 December 1953		
Air Flow, m^3	113			57			113			226			170			226		
Components	Number Conc. Particles	Conc. Weight μg	Avg. Conc. μg	Number Conc. Particles	Conc. Weight μg	Avg. Conc. μg	Number Conc. Particles	Conc. Weight μg	Conc. μg	Number Conc. Particles	Conc. Weight μg	Conc. μg	Number Conc. Particles	Conc. Weight μg	Avg. Conc. μg	Number Conc. Particles	Conc. Weight μg	Avg. Conc. μg
Minerals	(Many)	1–10	1	(Many)	1–10	1	(Many)	1–10	1	(Many)	1–10	1	(Many)	1–10	1	(Many)	1–10	1
Quartz	3+			1			3+			3+			3+			4		
Mica	1			1			1			1+			2			3+		
Feldspars																		
Magnetite	1																	
Rhyolite																		
Glass	1+									1+								
Carbonaceous Particles	(Many)			(Many)	1–10	1	(Many)	1–10	1	(Many)	1–10	1	(Many)	1–10	1	(Many)	1–10	1
Pollen:																		
Oak	1+																	
Elm																		
Pine				1			1			1+			2			3+		
Grass				1+														
Ragweed																		
Fungal spores																		
Starch grains																		
Biological Material	(Many)			(Many)			(Many)			(Many)			(Many)			(Many)		
Cotton																		
Cellulose																		
Paper																		
Starch																		
Wool, other fibers																		
Others																		
Manufactured Products	(Many)			(Many)			(Many)			(Many)			(Many)			(Many)		
Iron or rust																		
Rubber																		

Table IIc. RESULTS OF FILTER ANALYSES FOR ZEARING SITES IN ST. LOUIS AND VICINITY
(EAST ST. LOUIS – NO. 26)

Area	11 June 1965			25 June 1965			24 July 1965			8 October 1965			7 December 1965			24 November 1965		
TSP ($\mu g/m^3$)	98			124			110			172			117			77		
Component	Concentration, particles	Size range, μ	Avg. size, μ	Concentration, particles	Size range, μ	Avg. size, μ	Concentration, particles	Size range, μ	Avg. size, μ	Concentration, particles	Size range, μ	Avg. size, μ	Concentration, particles	Size range, μ	Avg. size, μ	Concentration, particles	Size range, μ	Avg. size, μ
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]			[illegible]			[illegible]			[illegible]			[illegible]			[illegible]		
[illegible]	[illegible]			[illegible]			[illegible]			[illegible]			[illegible]			[illegible]		
[illegible]																		
[illegible]	[illegible]			[illegible]			[illegible]			[illegible]			[illegible]			[illegible]		
[illegible]																		
[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]																		
[illegible]	[illegible]			[illegible]			[illegible]			[illegible]			[illegible]			[illegible]		
[illegible]							[illegible]											
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[illegible]	[illegible]			[illegible]			[illegible]			[illegible]			[illegible]			[illegible]		
[illegible]																		
[illegible]																		

Table 11d. RESULTS OF FILTER ANALYSES FOR SELECTED SITES IN ST. LOUIS AND VICINITY (DONOVAN STREET – NO. 9)

Date	18 June 1974			28 June 1974			16 July 1974		
TSP ($\mu g/m^3$)	101			105			74		
Components	Quantity, tenths	Size range, μm	Avg. size, μm	Quantity, tenths	Size range, μm	Avg. size, μm	Quantity, tenths	Size range, μm	Avg. size, μm
Minerals	(9+)	1-80	3	(9+)	1-18	6	(8)	1-60	7
Quartz	6			5+			4+		
Calcite	3			2+			3		
Feldspars	1+								
Hematite	1						1+		
Misc.									
Combustion Products	(1)			(3+)	1-30	3	(2+)	1-45	3
Soot:									
Oil									
Coal				3+			1		
Coke							1+		
Glassy									
Fly ash									
Incinerator									
Fly ash									
Burned wood									
Burned paper									
Magnetite									
Biological Material	(1+)	1-70	30	(0+)			(0+)		
Pollen									
Spores									
Paper									
Starch									
Misc. plant tissue	1+								
Miscellaneous	(0+)			(0+)			(0+)		
Iron or steel									
Rubber									

Table IIa. [illegible]

Site	[illegible]									[illegible]					
Date	[illegible]									[illegible]					
TSP ($\mu g/m^3$)	[illegible]									[illegible]					
Component	[illegible]									[illegible]					
[illegible]															
[illegible]															
[illegible]									

Table 13. RESULTS OF REPLICATE ANALYSES OF ST. LOUIS FILTERS

Site	East St. Louis - No. 26					
Date	28 June 1974		16 July 1974		7 November 1974	
TSP ($\mu g/m^3$)	154		112		138	
Laboratory	A	B	A	B	A	B
Analyses	1	1	1	1	1	1
Components						
Minerals	(93)	(48)	(77)	(23)	(21)	(43)
Quartz	20		30		4	
Calcite	40		45		16	
Feldspars	3					
Hematite	30		12		1	
Mica						
Combustion Products	(7)	(52)	(21)	(77)	(79)	(57)
Soot:						
Oil	5					
Coal	1	4		37		9
Root			21		79	
Glassy fly ash	1				tr	
Incinerator fly ash	<1	48		40		48
Burned wood						
Burned paper						
Magnetite						
Biological Material	(<1)	(<1)	(1)	(<1)	(<1)	(<1)
Pollen						
Spores	<1		tr			
Paper			tr			
Starch						
Misc. plant tissue	<1		1			
Miscellaneous	(<1)	(<1)	(<1)	(<1)	(<1)	(<1)
Iron or steel	<1		<1			
Rubber						

Table 14. CITYWIDE COMPOSITE SUMMARY OF FILTER ANALYSES IN ST. LOUIS

No. of filters	26	
	Quantity, percent	
Components	Average	Range
Minerals	(79)	21-99
Quartz	26	4-50
Calcite	40	16-68
Feldspars	2	0-20
Hematite	7	0-30
Mica		
Other	<1	0-5
Combustion products	(21)	1-79
Soot:		
Oil	2	0-5
Coal	<1	0-2
Misc. soot	16	0-79
Glassy fly ash	2	0-10
Incinerator fly ash	<1	0-2
Burned wood	<1	
Burned paper	<1	
Magnetite		
Carbon black		
Other		
Biological material	(<1)	0-5
Pollen	<1	
Spores	<1	
Paper	<1	
Starch	<1	
Misc. plant tissue	<1	0-5
Leaf trichomes		
Miscellaneous	15 (4)	0-10
Iron or steel	<1	
Rubber	15 4	0-10
Other		

A novel sampling device, known as the streaker,[2] allowed collection of particulate material for subsequent determination of 18 metals with a 2-hour time resolution. This device draws an air sample at a rate of 2 liters per minute through a strip of Nuclepore filter. The sampling head moves at a rate of 2 millimeters per hour which allows the collection of particulate matter for several days of unattended operation. The Nuclepore strip can then be removed for elemental determination of the particulate by proton-induced x-ray emission analysis.[3] This technique is useful for determining the following 18 elements: aluminum, silicon, phosphorus, sulfur, carbon, potassium, calcium, titanium, vanadium, chromium, manganese, iron, nickel, copper, zinc, bromine, strontium, and lead. The use of this powerful analytical technique, combined with the short time resolution of the sampling device, greatly facilitates correlation of the chemical properties of particulate with meteorological parameters.

The AARS studies also included cascade impactors that were controlled by a wind direction sensor. Up to four impactors were operated such that each was operating only when the wind was from a desired direction. For example, each of four impactors could be run only when the wind was from a particular 90 degree sector so that the particle size distribution as a function of the four selected wind directions could be determined. The impactors utilized were low flow rate instruments so that long sampling times (e.g., 1 week) were required. The particulate collected in the impactor stages was also subjected to proton-induced x-ray emission analysis, indicating the elemental composition as a function of particle size.

The results of the study are far too comprehensive for presentation here and will be published separately by EPA. An example of the usefulness of the techniques employed is demonstrated in Figure 16 which shows the temporal variations in the concentration of vanadium, a convenient tracer for residual fuel oil combustion, at the two St. Louis sampling locations included in the AARS program. The Broadway and Hurck site was selected

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because of its proximity to the heavily industrialized area on the south side of St. Louis and the Municipal Court site was chosen because it is typical of the downtown area. Two large peaks in the vanadium concentration at Broadway and Hurck can be seen late in the day of July 23, 1975. The wind, displayed at the top of the figure, was coming from the 170 - 230 degree sector where the industrial complex is located. At the same time much smaller peaks occur at the Municipal Court site. Whether the increase in vanadium concentrations at the downtown site, which is five miles away from the Broadway and Hurck site, is attributable to the same source is impossible to determine.

The vanadium concentration at both sites shows a peak around midday of July 25, 1975. The wind during that period is from the 10 - 15 degree sector, nearly the opposite direction as that observed on July 23. The peak at the Broadway and Hurck site is considerably smaller than on the previously discussed day and the concentration at the Municipal Court site was only slightly less. The implications of these observations are two-fold; first, vanadium concentration at the Municipal Court site can be increased when the wind is from the 170 - 230 degree sector or the 10 - 50 degree sector but that the increase in concentration is about the same in both cases. Second, the vanadium concentration at the Broadway and Hurck site can also be increased with the wind from either of the two wind directions, but that the increase is much greater when the wind is from the southwesterly direction.

URBAN ACTIVITY FACTORS

Construction Activity

For the past 20 years, an extensive urban renewal program has been conducted in St. Louis. Most of the construction activities have been occurring in the downtown area, as shown in Figure 17. Urban renewal activities include demolition of structures, land clearing, construction of new buildings, and rehabilitation of older buildings. All of these activities generate particulates and have been contributing to total particulate emissions, thus influencing the TSP concentrations in the city.

The monitoring sites closest to the areas of construction activity are sites 11, 13, 18, and 20. The periods of urban renewal activities and the TSP trends at the sampling sites are summarized in Table 15. Site 11 is near the West End Urban Renewal area but started monitoring TSP 6 years after the renewal activities began. TSP concentrations have been decreasing somewhat and are presently around the annual primary standard. Urban renewal activities in the West End area have been slow in progress and scattered so this might be expected to have little effect on TSP concentrations at site 11.

Site 13 is near the Mill Creek Valley area where urban renewal began in 1958, 10 years before monitoring started, and ended in 1972. TSP concentrations have decreased 60 to 70 $\mu g/m^3$ since monitoring started, the decline beginning before the finish of renewal activities in the Mill Creek Valley area. But it is possible that urban renewal contributed to the high TSP concentrations at site 13 and cessation of some activities which occurred during the early stages contributed to the decline of 70 $\mu g/m^3$.

Sites 18 and 20 are in the downtown area and thus influenced by urban renewal in the Stadium Complex, LaSalle Park, and Plaza Square areas. Renewal has been occurring since 1954, before either monitor was operating,

Figure 17. Urban renewal in St. Louis

Table 15. [illegible] IN ST. LOUIS

Year	Urban renewal areas	TSP levels - annual geometric mean, µg/m³			
		site 11	site 13	site 18	site 35
1956	Mill Creek				
1957					
1958					
1959					
1960					
1961					
1962					
1963					
1964					
1965					
1966					
1967					
1968			134	146	
1969			141	148	
1970				125	
1971		91	91	118	
1972		79	79	98	
1973		82	72	92	
1974		78	78	90	

a - R - rehabilitation of older structures
D - demolition of older structures
C - construction of new structures

and probably has contributed to the high TSP concentrations recorded. The rise in TSP concentrations at site 20 during 1969 and 1970 has been attributed to the land clearing and construction of the nearby Post Office building. TSP concentrations have decreased 80 $\mu g/m^3$ since 1954 at site 20 and 100 $\mu g/m^3$ since 1968 at site 18.

Urban renewal activities have probably been contributing to the high TSP concentrations at several sites in the city. But it is not possible to determine how much of a contribution - most urban renewal areas were begun long before TSP monitoring started and TSP concentrations have undergone substantial declines even while nearby urban renewal activities were being conducted, though the intensity of the activities may have decreased.

Land Use and Traffic Activity

The pattern of land use in St. Louis is influenced by the Mississippi River. The central part of the city is located on the Missouri shore of an eastward bend in the river and the city's industrial areas are located along the river, north and south of the downtown area. Land use is densely residential around the central business district and the industrial areas and becomes increasingly less dense through the suburbs. The Illinois shore is lined with industry from Alton and Wood River in the north to south of St. Louis. Beyond the industrial areas, land use is residential but not as dense or as wide as the Missouri side.

TSP concentrations tend to follow the land use patterns, being highest in the industrial areas (97 $\mu g/m^3$ in Missouri, 98 $\mu g/m^3$ in Illinois), followed by the center city (80 $\mu g/m^3$ in St. Louis) and the commercial areas (75 $\mu g/m^3$ in Missouri, 69 $\mu g/m^3$ in Illinois). Residential and remote areas in Missouri were lowest (61 $\mu g/m^3$ and 40 $\mu g/m^3$, respectively). Table 16 shows the averaged 1974 TSP means for the sampling sites by their predominant surrounding land use type.

Table 16. TSP BY LAND USE

	Predominant land use type	Averaged 1974 TSP ug/m^3	Sites
Missouri	industrial	97	1,5,6,14,17,19
	residential	61	2,3,4,9,10,11
	commercial	75	7,8A,12,13
	remote	40	8
	center city	80	18
Illinois	industrial	98	22,26,29,30,31,3 33,35,35
	residential		
	commercial	65	23,24,28

Average daily traffic data are available for several of the sampling sites in the city of St. Louis (see Table 17). No correlation could be found between ADT and the 1976 geometric mean TSP concentration. The distance between the monitor and the street on which traffic data was taken was rather large for several of the monitors, thus reducing the ADT per unit of slant distance. It appears that the land use and general activities surrounding a site are more important than the daily traffic which is but one of the many activities that can influence TSP concentrations. An exception to this is the Shreve Road-170 Site which is obviously influenced by traffic.

Street Sweeping and Salting

Other urban activities which can influence TSP concentrations are street sweeping and salting. The Department of Streets of the City of St. Louis salts major and secondary arterials but no residential streets during and after snow storms and the state's highway department salts the highways and ramps. Salting is performed on an average of 10 occasions during a winter with 14 the maximum. Dried salt ground and resuspended by automobile tires contributes to the TSP concentrations during the winter at sites near major streets and highways.

Table 17. TSP VERSUS ADT ON NEARBY STREETS

Site	Street	ADT Both directions	TSP
8	US 67	31,057	58
	I-270	75,750	
7	St. Charles Rock Rd.	35,717	88
6	Chippewa	19,155	81
	Watson	8,784	
10	US 40	101,496	59
11	Goodfellow	16,101	70
	King	13,097	
12	Grand	19,668	81
	Gravois	24,961	
13	Forrest Park	24,231	70
	Grand	23,131	
14	I-70	107,390	112
	Shreve	5,475	
15	Riverview	16,787	70
	I-270	48,250	
17	Manchester	12,096	91
	Hampton	17,106	
18	Market	15,697	80
	16th	14,578	
19	Maryland	8,130	126
	Broadway	13,919	

The Department of Streets is also responsible for street sweeping. Every street in the city is swept on a biweekly basis except streets in the downtown area which are swept daily and streets in poorer neighborhoods which are swept weekly. The sweepers used are mechanical, not vacuum. Frequent sweeping removes dirt which might be ground by traffic and resuspended by traffic or winds, thus reducing contributions of fugitive dust to TSP concentrations. But the sweeping activity itself resuspends dust and can cause temporarily higher concentrations of TSP.

Street sweeping and salting can contribute or diminish TSP concentrations but the extent to which they are influencing TSP in St. Louis cannot be determined with the data available at present.

NETWORK DESIGN AND MONITOR SITING

The sampling sites operated by the city of St. Louis are located throughout the city, with emphasis on the industrial and center city areas. The Illinois sampling sites are concentrated in the industrial areas of Madison and St. Clair Counties along the river. St. Louis County's sampling sites are in locations which surround the city. The locations of the sampling sites in the St. Louis Metropolitan Area are shown in Figure 2 and information about them is summarized in Table A-1 in the Appendix.

For St. Louis City, the central business district is represented by sites 18 and 20, residential areas by sites 9, 10 and 11, commercial areas by sites 12 and 13, and industrial areas by sites 14, 15, 17 and 19. In St. Louis County, the residential areas are represented by sites in Bellefontaine Neighbors and Clayton (2, 3, and 4), the commercial areas by sites in St. Ann and Jennings (7 and 8A), industrial areas by Bellefontaine Neighbors and Lemay (1, 5 and 6), and remote areas by site 8. The commercial areas in Madison and St. Clair Counties are represented by sites in Belleville, Collinsville and Edwardsville (23, 24 and 28), and the industrial areas by sites in Alton, East St. Louis, Granite City and Wood River (22, 26, 29, 30, 31, 32, 33, 34 and 35).

The design of the monitoring network in St. Louis City is adequate for recording the variety of air quality situations in the city. In St. Louis County, industrial, commercial and residential areas are well covered but the rural areas which cover much of the county are represented by only one monitor in the north of the county. In Madison and St. Clair Counties, the network is designed to monitor the industrial and commercial areas but does not cover the residential and rural areas of the two counties. There is only one site in the metropolitan area, in St. Louis County, which could be considered to be monitoring background concentrations.

The siting of the monitors varies considerably. The exposure of some may be limited somewhat by nearby buildings, walls, or shrubs (sites 2, 5, 6, 7, 10, 15, 22 and 33). Some monitors were placed very high (sites 4, 18, 22 and 29) so that TSP concentrations would tend to decrease due to the height; others are near ground level (sites 2, 3, 5, 6,) and 8) where they could be affected excessively by immediately local ground-level sources. The very low monitors have been recently raised so that now most are in the height range of 10 to 40 feet. One of the higher monitors (site 18, the NASN site) is located in the downtown area where tall buildings predominate and monitors are difficult to place at lower levels. This monitor has been operated for 18 years at this location and, regardless of its height, it is valuable for its historical data. Its placement is typical of NASN practices in the past. Some monitors have been placed where they may be excessively influenced by some local source so that they are not recording TSP concentrations which are representative of the surrounding area - local sources include agricultural fields (sites 8 and 27), incinerators or boiler stacks (site 9), and highways or dirt roads (site 14).

IMPLEMENTATION PLANNING

Institutional Framework

Several agencies are involved in air pollution control in the St. Louis metropolitan area. In Missouri, the State Division of Environmental Quality has delegated the authority for air pollution control to two local agencies in the metropolitan area - the Division of Air Pollution Control of the City of St. Louis and the Air Pollution Control Division of St. Louis County. The city's agency was formed in 1961 and the county's agency in 1967. Both had adopted air pollution regulations in 1967 which were, for the city, a revision of existing regulations. These regulations were approved by the Federal Government after the Clean Air Act of 1970 as adequate for controlling air pollution in the St. Louis metropolitan area. The state of Missouri followed up by adopting state-wide air pollution regulations in 1972 which were equivalent to the regulations of the local agencies.

In Illinois, the Environmental Protection Agency, formed in 1972, is responsible for air pollution control activities throughout the state. Field operations are conducted by the regional offices of Illinois EPA. The air pollution control regulations currently in use were adopted in 1972; regulations existed prior to that time.

Implementation Planning Methodology

Two Implementation Plans, one for Missouri and one for Illinois, covered the air quality and emissions data and the proposed regulations for the St. Louis metropolitan area.

The Missouri SIP used 1971 TSP air quality data collected by the city and county agencies and a particulate emissions inventory based on older inventories and updated to 1970. The regulations adopted in 1967 by the city and county were used in the modeling. They are presented in Table A-2

in the Appendix and include a "hot spot" regulation which requires additional emission controls on industries already meeting the emissions standards when air quality in the vicinity continues to exceed the standards. These regulations were applied to the existing emissions sources by the IPP model which was run by U.S. EPA. The results of the modelling showed that the secondary TSP air quality standard would be met when full compliance with the current regulations, including the hot spot regulation, was achieved.

The Illinois SIP used emissions, air quality and meteorological data for 1968, see Table 18. A set of regulations was proposed and included two process weight rate tables, one being more stringent. The Argonne strategy model was used to assess the effectiveness of the control strategy for Set I pollutants (sulfur dioxide and particulates) - it determines the regulated emissions based on the emission standards and uses them as input to the AQDM dispersion model. The Argonne strategy model results are in error as much as 20 percent but will produce overestimates in most cases which should not affect planning. Growth analysis was used to evaluate the proposed control strategies in terms of their effectiveness in future years. It was determined that the annual secondary TSP standard would be attained and maintained with the enforcement of the Illinois regulations, provided that the Missouri regulations were fully enforced, including the "hot spot" regulation, and the secondary standard was attained on the other side of the river.

It would be advisable to check the consistency of the emission inventories used in the Implementation Plans with the best current estimates of emissions. This would permit an assessment of where the emphasis on emissions reductions was placed in terms of where the emphasis should have been placed.

Some industries on both sides of the river have applied more stringent controls than was necessary because there were easier to apply than lesser controls.

Table 18. ST. LOUIS (ILLINOIS) AQCR AIR QUALITY AND EMISSIONS DATA USED IN THE SIP

	Point	Area	Total
Existing emissions, 1968, TPD	420	108	528
% reduction in emissions with regulations	83	66	80
Emissions, TPD, after regulations	72.8	36.7	109.6
Maximum receptor TSP concentration, 1968 geometric mean	142		
Maximum receptor TSP concentration, 1975 geometric mean	60		

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SECTION III

SUMMARY AND CONCLUSIONS

SUMMARY

Air Quality Levels

The 1974 annual geometric mean TSP concentrations in the St. Louis Metropolitan Area ranged from 40 $\mu g/m^3$ at the remote site to 50 to 70 $\mu g/m^3$ at the residential sites, 60 to 80 $\mu g/m^3$ at the commercial sites, and generally over 80 $\mu g/m^3$ at the industrial sites. The particulate standards were exceeded at most of the 33 sites operated in the metropolitan area in 1974. The annual primary standard was exceeded by 16 of the sites and the annual secondary standard was exceeded by a total of 26 sites. The 24-hour primary standard was exceeded 1.1 percent of the sampling days and the 24-hour secondary standard was exceeded 8.7 percent of the sampling days.

The TSP concentrations experienced in the St. Louis Metropolitan Area appear to be the result, primarily, of the industrial character and land use patterns of the area. The dispersion characteristics of the area do not appear to influence TSP concentrations significantly.

The St. Louis area is highly industrialized, the principal industries being primary metals, fabricated metals, transportation equipment, food products and machinery. The large, heavy industries with large particulate emissions are mostly located along the Mississippi River. There are a number of quarries, cement plants, and small, clean industries which are located farther away from the river.

Many of the prominent industries in the St. Louis area are concerned with activities which result in considerable fugitive emissions - such activities include materials crushing, grinding, transfer, or storage, and metallurgical furnaces. In addition, fugitive dust emissions are associated with the unpaved roads and lots, storage piles, trucking, and construction found in the industrial areas. The existing emission inventories are inconsistent in several places and have generally ignored the contributions of fugitive dust and emissions. Nevertheless, they indicate that industrial processes, primarily, and industrial and utility fuel combustion are the largest sources of particulate emissions in the area. The contribution of industry to total particulate emissions would probably be seen to be even larger if fugitive dust and emissions were taken into account.

The sampling sites located near the industrial areas recorded high concentrations of TSP - annual mean TSP concentrations exceeded 100 $\mu g/m^3$ in 1974 in the industrial areas in Granite City and at the southern tip of St. Louis City. The pattern of higher TSP concentrations on weekdays also seems to show the influence of industrial emissions on air quality. A modeling study performed by EPA showed that industrial processes were important contributions to TSP levels above background at certain sites. In addition, uninventoried fugitive dust and fugitive emissions in the industrial areas are probably important sources of particulates and caused in part the underpredictions of the modeling study.

The central business district of St. Louis and many of the industries are located along the Mississippi River. Patterns of TSP concentrations are closely related to these land use patterns, being highest in the CBD and industrial areas and diminishing through the residential areas.

Dispersion and precipitation are known to effect TSP concentrations but a study of them showed that they are not responsible for TSP trends.

Air Quality Trends

Seven sites in St. Louis County experienced an average decrease of 21 $\mu g/m^3$ from 1968 to 1974. Four sites in St. Louis showed an average decrease of 72 $\mu g/m^3$. TSP concentrations decreased an average 50 $\mu g/m^3$ at twelve sites in Madison and St. Clair Counties. These downward trends are the result of fuel switching, enforcement of the regulations and emission controls.

Coal, at one time, was the major fuel for residential space-heating, industries and utilities. Since the second World War, conversion from coal to other fuels has been occurring in St. Louis as in other cities. The number of residences using coal has dropped to an insignificant level. Decreases in coal usage by industries and utilities have also occurred but these have been smaller.

The enforcement of the regulations has resulted in fuel switching and emissions controls on both sides of the Mississippi River but with different effects. The air pollution control regulations for St. Louis City and St. Louis County are much the same and are average to less than average in stringency when compared with the regulations of most states in the nation. The Illinois regulations are generally average or better than average in stringency. Enforcement on the Missouri side started and resulted in the compliance of many sources earlier than on the Illinois side.

Emission controls have been applied by many industries on both sides of the river and have resulted in considerable reductions in emissions. The St. Louis City and County regulations, however, are not as stringent as

they might be, so further emissions reductions could probably be obtained by increasing the stringency of the regulations. Further emission reductions are expected as sources on the Illinois side come into compliance.

CONCLUSIONS

The St. Louis Metropolitan Area experiences high TSP concentrations and many of the sampling sites exceed the standards. The high TSP concentrations are the result of emissions from the large numbers of industries, especially the many heavy industries. TSP concentrations are highest in the industrial areas and CBD of St. Louis. Air quality has been gradually improving over time due to decreasing emissions from coal combustion and from industrial processes and fuel combustion. Compliance is complete on the Missouri side but the regulations are not as stringent as they could be, and special attention must be paid to the "hot spot" areas. This could be ameliorated by the enforcement of the "hot spot" regulation. On the Illinois side, compliance is not yet complete because the program started later. Considerable reductions in emissions are expected as sources come into compliance. The high TSP concentrations currently being experienced will probably also decrease considerably as emissions decrease. But it is likely that some of St. Louis' characteristics -- the river valley and seasonal effects on dispersion, the land use patterns, and fugitive emissions and dust -- will hinder the achievement of TSP standards in certain areas of the city.

APPENDIX A

SUPPLEMENTARY INFORMATION

Table A-1-4. ST. LOUIS, MISSOURI SAMPLING SITE INFORMATION

Table A-1-a (continued). ST. LOUIS, MISSOURI SAMPLING SITE INFORMATION

[illegible]	Code	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	HVS				[illegible]		
							[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	29	[illegible]	[illegible]	St. Louis		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
[illegible]	31	[illegible]	[illegible]	St. Louis		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
[illegible]	33A	[illegible]		St. Louis		[illegible]					[illegible]	[illegible]	

Table A-1-6. ST. LOUIS, ILLINOIS SIDE SAMPLING SITE INFORMATION

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table A-3. SUMMARY OF AIR POLLUTION CONTROL REGULATIONS FOR ST. LOUIS CITY, ST. LOUIS COUNTY, AND THE STATE OF ILLINOIS

Regulation	St. Louis City and St. Louis County	Illinois
Process weight	Curve A in Figure A-1 specific regulations for cupolas	Curve A in Figure A-1 for existing sources curve B in Figure A-1 for new sources Specific regulations for catalyst regenerators sinter processes portland cement corn wet milling processes coke oven cupolas
Incinerators (maximum allowable emission rate)	> 200 lbs/hr refuse burning capacity 0.3 gr/SCFD all other 0.3 gr/SCFD	> 60,000 lbs/hr refuse burning capacity > 2,000 lbs/hr refuse burning capacity 0.08 gr/SCFD all other existing incinerators 0.2 gr/SCFD all other new incinerators 0.1 gr/SCFD
Fuel burning (maximum allowable emission rate)	Curve A in Figure A-2 also a provision based on stack height	Solid fuel - curve B in Figure A-2 liquid fuel - curve C in Figure A-2
Visible (maximum allowable opacity)	40% for existing installations 20% for new installations	20% for new fuel burning sources >250 x 10^6 Btu/hour 10% for new portland cement processes 30% all other sources
Fugitive dust (prohibitions)	Unnecessary emissions from materials handling prohibited reasonable precautions shall be taken	Visible fugitive emissions from any process beyond property line prohibited; size of particles crossing property line shall not exceed 40 μm
Size limitation[a]	Maximum size limit of 40 μm on all sources	

[a]City only.

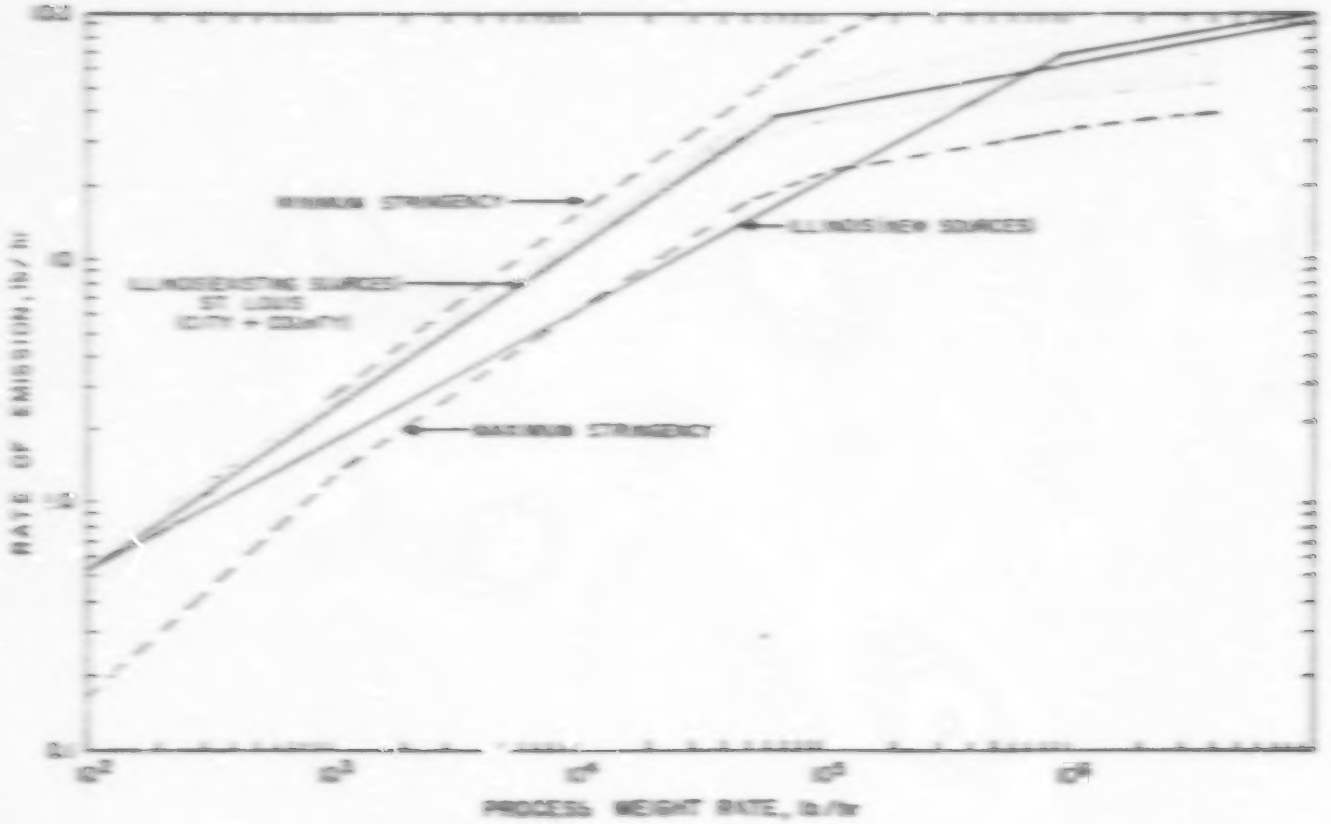

Figure A-1. Process weight regulations

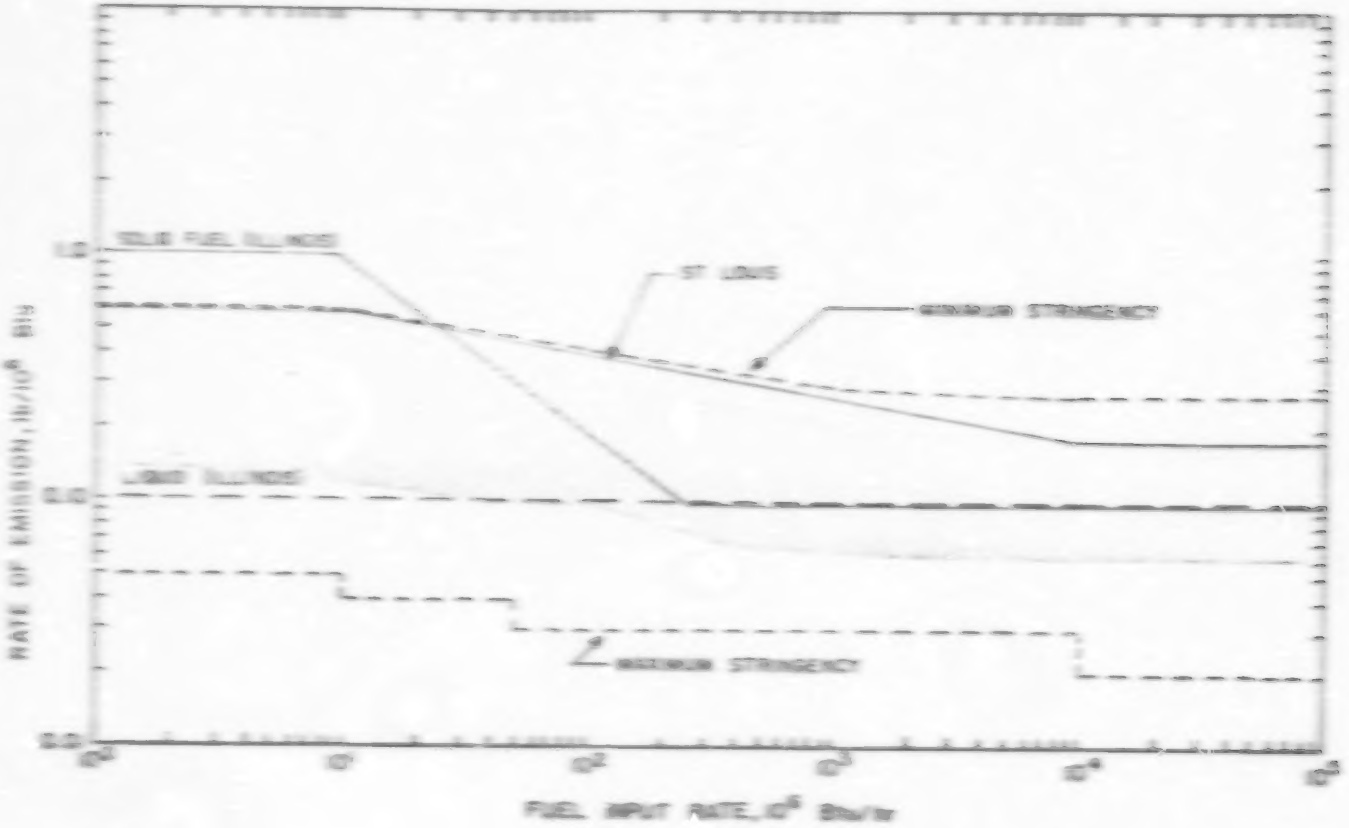

Figure A-1. Fuel combustion emissions regulations